WASATCH FAULT

SOUTHERN PORTION

EARTHQUAKE FAULT INVESTIGATION & EVALUATION

A GUIDE TO LAND USE PLANNING

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BY

LLOYD S. CLUFF, GEORGE E. BROGAN & CARL E. GLASS

A GUIDE TO LAND USE PLANNING

FOR

UTAH GEOLOGICAL & MINERALOGICAL SURVEY

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Project G-12069A

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Attention: Dr. William P. Hewitt
Director

Gentlemen:

WASATCH FAULT - SOUTHERN PORTION
EARTHQUAKE FAULT INVESTIGATION AND EVALUATION

The enclosed report and maps present the results of our investigation and evaluation of the Wasatch fault from near Gunnison to Alpine, Utah.

The completion of this work further extends the regional geologic investigation and evaluation of the Wasatch fault zone and marks another important step in Utah's approach to minimizing the effects of earthquake and geologic hazards.

We appreciate the opportunity of assisting the Utah Geological and Mineralogical Survey with this interesting and challenging study. If we can be of further assistance, please do not hestitate to contact us.

Very truly yours,

Lloyd S Cluff

Lloyd S. Cluff
Principal Engineering Geologist

LSC:sw
Enclosure

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COVER - Aerial view looking southeast toward Maple Canyon. Wasatch fault is marked by steep scarp (in shadow) and triangular facets on the range front.

INTRODUCTION

Damage from earthquakes is generally manifest in four separate forms: (1) damage due to fault displacement; (2) damage due to shaking; (3) damage due to ground failure; and (4) damage due to tsunamis (seismic sea waves).

Damage resulting from surface fault displacement occurs whenever works of man are located astride a fault trace that experiences surface offset. In Utah the potential for damage is high and the consequences of surface faulting are severe due to the juxtaposition of major population centers and the active Wasatch fault. It is evident that most urban development along the Wasatch fault has been proceeding without regard to the consequences of future fault displacement and many structures straddle active fault traces. If another fault displacement and attendant strong earthquake should occur along the Wasatch fault, structures would be torn apart by the fault offset. To compound this situation, no detailed maps presently exist to aid planners and developers in avoiding active fault hazards. This has resulted in continued development along potentially unsafe areas.

The purpose of this report is to identify areas of high risk along the Wasatch fault and to recommend positive steps to be taken to reduce future fault-induced damage. This report serves as a first step to minimize the consequences of future strong earthquakes along the Wasatch fault by: (1) insuring a better understanding of the fault and earthquake risk problem; and by (2) informing governmental agencies and urban planners of potential fault hazards. Urban development should be allowed to proceed along the Wasatch fault; however there should be definite restrictions based on knowledge gained by thorough engineering geologic investigations. These restrictions should be implemented during the early planning stages of development and incorporated into long-range regional plans. Only in this way can development proceed safely along the Wasatch fault zone.

SUMMARY OF CONCLUSIONS

1. The Wasatch fault is an active fault.

2. The Wasatch fault is part of a zone of active faults extending from Southern Utah into Idaho and Montana. Significant fault displacements are anticipated along active faults within this zone.

3. Generally the risk from surface faults actually passing through a structure is low, however approximately 90% of Utah's population is located along the Wasatch fault zone. This significantly increases the risk from surface faulting and other related earthquake hazards.

4. The Wasatch fault will generate large earthquakes in the future; many of these earthquakes may be accompanied by surface faulting. Structures located astride fault traces that exhibit surface displacement will be torn apart.

5. It is probable that future fault displacements will follow the most recently developed planes of weakness. The most likely locations for future fault displacements are indicated by Class I and II lines on the accompanying maps.

6. Vertical deformation and tilting over a wide area may occur as a result of future surface fault offsets and earthquakes. This should be considered by local governments in planning and zoning, especially where multi-story buildings are planned.

7. The proximity of a particular site to an active fault is not as important as the ground conditions beneath the site, provided that the site is not astride an active fault.

8. Numerous landslides coincident with the Wasatch fault zone, exist along the Wasatch Range front. These areas are potentially hazardous to future development.

9. Faulting has been found extending into areas not covered by our photography, and there is a possibility that active fault traces exist outside the area of this investigation.

SUMMARY OF RECOMMENDATIONS

1. Before private or public development is allowed to continue along the Wasatch fault, comprehensive geologic and engineering investigations and evaluations should be required in order to define the exact locations of surface fault ruptures and related geologic hazards.

2. The rapid urbanization along the fault zone in the Utah County area of this report should be given immediate consideration for detailed mapping and land-use zoning.

3. Attention should be given to the evaluation of overall site stability to assure that a site can be expected to remain substantially intact during an earthquake.

4. Detailed studies should be carried out for all existing or potential landslide areas before development is allowed in their vicinity.

5. Schools, hospitals, emergency services, and other buildings of high socio-economic importance should not be built astride the traces of active faults.

6. High pressure transmission lines, such as water, gas, petroleum, chemical and other volatile products should avoid crossing the Wasatch fault. Where these transmission lines must cross the fault, they should do so at or near the ground surface and at right angles to the strike of the fault. Where these transmission lines cross the fault they should incorporate appropriate safety features, such as flexible joints and emergency shut-off valves.

7. Contingency plans to be followed in the event of a large earthquake should be drawn up.

8. A Review Board should be implemented to:
   (1) establish and revise safety criteria for the Wasatch fault and structures therein with respect to risk zoning.
   (2) review all proposed development projects for the adequacy of their specific safety criteria and to make recommendations concerning these criteria;
   (3) gather and make available data developed from specific projects under their jurisdiction; and
   (4) to complement the functions of local building departments and local city and county planning departments.

9. Adequate legislation pertaining to fault zone hazards, particularly relating to schools, hospitals, emergency services, high occupancy structures, and subdivisions should be introduced on a statewide and local level.

10. Building code standards should be related to fault zone problems.

11. Similar investigations should be completed for critical areas not covered by this or our previous investigation.

ACTIVE FAULTS AND ASSOCIATED RISKS IN UTAH

Utah is traversed by several active faults, as shown on Figure 1. Past seismic activity in Utah has been high as evidenced by geologically young offsets along these faults as well as historic accounts of strong earthquake activity. This high degree of earthquake activity is expected to continue in the future. Utah has not had a severe earthquake in recent years and there is a tendency for a rather complacent "it can't happen here" attitude to develop during such periods of earthquake quiescence. However, the potential for a large earthquake is high in Utah and even a moderate earthquake (such as Caracas 1967 and Managua 1972) could cause extensive damage due to the unique location of Utah's population, near the Wasatch fault.

The Wasatch fault is a major active fault that extends from near Gunnison on the south, northward into southern Idaho traversing through the most densely populated areas of Utah as shown on Figure 1. The Wasatch fault will generate large earthquakes in the future; many may be accompanied by surface faulting.

The present risk from surface faulting is high in areas where development has taken place astride the Wasatch fault. Risk can be minimized during future development by increased awareness of the fault, knowledge of the precise location of the fault, and knowledge of current methods used in dealing with faulting and earthquake problems.

This report presents locations of active traces of the Wasatch fault from Corner Canyon to Gunnison, along with current methods used in dealing with fault and earthquake problems in urban areas.

Information regarding locations of the active traces of the Wasatch fault from Corner Canyon to Brigham City is available in our previous report (Cluff, et al., 1970).

Generally, the risk from surface faults actually passing through structures is low, seldom being more than a few percent for most western states. However, Utah is in a unique position in that approximately 90% of the population is located within or along the active Wasatch fault zone. This juxtaposition of population density and active fault hazard significantly increases the risk of damage due to surface faulting and other related earthquake hazards.

Many variables influence the degree of risk that may be associated with urban development along or near an active fault zone. These variables include geologic factors such as: exact location of the fault, type of fault (direction of potential displacement, e.g. horizontal, vertical, or oblique), amount of potential displacement, Richter magnitude of the earthquake, size of the zone of earthquake energy release, and near surface geologic and soil conditions. Land-use factors (which are those that can be controlled presently by man) also influence the degree of the risk. These land-use factors include building occupancy, building height, structural system and quality of construction.

As Utah's population increases and urban areas expand, there is a tendency to build on marginal land or to use potentially more hazardous sites along the Wasatch fault zone. These land-use problems are becoming increasingly serious. However, it is not clear at this time precisely how they should be treated. It is neither feasible nor necessary to prohibit the use of all land within and immediately adjacent to the fault zone; on the other hand, building structures on sites that will almost certainly be destroyed during the next major fault movement is certainly unacceptable. Since future fault displacements will occur along the Wasatch fault, precautions should be taken to minimize the loss of property and life from the effects of surface displacement. Conscientious planning, utilizing geologic information, can avoid or reduce the risk associated with future fault displacements. Public welfare

along the Wasatch fault depends upon such conscientious planning and the ability to assess the following factors:

1. Accurate location of the Wasatch fault;
2. Expected location and extent of future ground rupture;
3. Maximum credible earthquake expected along the Wasatch fault.
4. The amount of displacement which can be expected during a single fault movement.

Once these factors are evaluated, and assuming that planning, zoning, development and construction can be responsibly guided, rational decisions can be made to reduce the risk from surface faulting to an acceptable level.

THE PURPOSE OF STUDY AND ORGANIZATION OF REPORT

The purpose of this study is two-fold: first, to delineate the location of active traces of the southern Wasatch fault zone, and to indicate the potential hazards that exist along it; and second, to recommend specific steps that can minimize the risk from fault and earthquake hazards.

To accomplish the first aim, a series of maps has been prepared, of the southern Wasatch fault zone from near Gunnison to south of Draper, accompanied by a descriptive text, and background information in a general discussion of faulting and earthquakes in Appendix A. We suggest that persons not familiar with active faults, earthquake problems, and related land-use planning problems read Appendix A in order to obtain a common understanding.

To accomplish the second purpose, we provide a discussion entitled, "Methods of evaluating fault-risk problems," which is a discussion of the types and sequence of investigations that should be used to minimize risk from active fault hazards. Appendix B provides examples of recent legislation introduced in California between 1970 and 1973 that deal with minimizing risk from active faults and earthquakes. The recommendations of this report bring into focus the action necessary to reduce risk from fault and earthquake hazards along the Wasatch fault.

SCOPE OF STUDY

The present investigation encompasses a regional geologic study to identify, delineate, and evaluate the active and potentially active traces of the Wasatch fault extending on the north from near Draper, to Gunnison on the south, as shown on Figure 1. The area investigated corresponds only to those areas covered by our special low-sun-angle aerial photography (locations are shown on the accompanying maps), which is a strip along the main Wasatch fault zone. We feel that this strip is the most critical zone for land-use considerations related to risk from surface fault rupture; however, surface faulting may extend beyond the limits of the area covered by this special photography and additional studies may be needed to evaluate these areas.

METHOD OF STUDY

The present investigation is a preliminary regional geologic investigation and evaluation of the Wasatch fault as outlined below.

REVIEW OF EXISTING KNOWLEDGE

All existing available published and unpublished information pertaining to the southern portion of the Wasatch fault has been reviewed. The main purpose of this review was to aid in establishing the location and width of the area considered for low-sun-angle photography. Information pertaining to the location of the Wasatch fault within the area of our photo coverage shown by previous workers was not utilized in the final preparation of the maps accompanying this report. The main sources of information included published and unpublished work by Dr. Ray Marsell, previously unpublished mapping by L. S. Cluff for Woodward-Clyde & Associates, Utah Geological and Mineralogical Survey published and unpublished work, publications by Brigham Young University, students and faculty, and published information by the U. S. Geological Survey.

AERIAL FIELD ORIENTATION

Aerial reconnaissance of the southern portion was conducted to further establish critical areas for photography, and to estimate the best time to take low-sun-angle aerial photography.

SPECIAL LOW-SUN-ANGLE AERIAL PHOTOGRAPHY

Over the past few years we have developed a technique of aerial photography that enables one to see fault features and patterns of faulting often unrecognizable on conventional aerial photographs. This technique was developed in 1967-1968 by Cluff and Slemmons (see Slemmons, 1969; Cluff & Slemmons, 1971; and Slemmons, 1972). and uses low-angle sun illumination to accentuate surface fault features by shadows and high-lighted areas. The object is to use shadowing and lighting effects produced by optimal sun illumination conditions. By photographing at the ideal time of day and

year, characteristic features, which are difficult or impossible to see on conventional aerial photos, are enhanced.

The results of this new photography along the Wasatch fault are illustrated in Figures 2 through 19. Figure 2 is a reproduction of a conventional vertical aerial photograph taken of the Wasatch fault just south of Bells Canyon; for comparison, Figure 3 is a low-sun-angle vertical aerial photograph of the same area.

Photographs were flown for the present project at an approximate scale of 1:12,000, both in winter and in summer, and in the morning and evening, to assure maximum coverage.

The aerial photographs were interpreted stereoscopically and faults and related features were mapped on clear acetate overlays. The most significant of these fault-related features were then plotted on 7-1/2 minute topographic maps.

FIELD STUDY

A brief reconnaissance was conducted to field check the features interpreted on aerial photographs. Because of time limitations, the scope of this investigation did not permit comprehensive field verification of all features. We have plotted all those features that we feel are fault-related in context with the map symbols as they are defined below in "Explanation of Maps."

The investigation outlined above is a preliminary regional investigation, and as such corresponds to step A of our "method of evaluating the fault risk problem"; this general method is outlined later in this report.

EXPLANATION OF MAPS

Upon completion of all aerial photo interpretation and field checking, this series of maps and report was prepared. The discussion below is also presented on the map legend.

MAP SYMBOLS

CLASS I - Prominent or obvious fault, or very fresh fault related feature

CLASS II - Probable fault or rupture, or fault showing a lack of recent activity

CLASS III - Possible fault or rupture

LANDSLIDE - Arrow shows direction of movement

Limits of present investigation

NOTE: DASHED LINES are approximate.
DOTTED LINES are concealed or inferred.

All lineaments have been mapped using special low sun-angle aerial photography taken especially for this project. The basic scale of the photographs is 1:12,000 or 1 inch represents 1,000 feet. Fault related features have been transferred from photographs to topographic base maps using a vertical sketchmaster and were checked by inspection and scale dividers.

We are confident that the features plotted as Class I faults are the locations of the most recent surface fault ruptures or fault-related ruptures. The Class I features commonly have significant vertical relief. For the present study, very fresh fissures related to earthquake shaking are also mapped as Class I.

It is our belief that all the Class I lineaments are well defined topographic features that mark the most recent surface fault ruptures. They are believed to have been mostly produced by, or related to, rapid fault displacements associated with strong earthquakes. Most Class I ruptures are undoubtedly the result of repeated fault displacements that are concentrated along previously established planes of weakness. Therefore, the Class I faults are the most likely candidates for significant future displacement. Some surface fault offset along the Wasatch fault may be due to slow tectonic creep, as has been documented along other faults. This problem should be considered in further evaluations.

The Class II features are probable surface faults or obvious surface faults showing much older activity. Most of the Class II features show little vertical relief and may be secondary fault-related features associated with ground failure or graben development.

The Class III features are possible surface faults. They have little or no vertical relief. Most of them appear to be related to the Class I and II fault features; however, some Class III features may represent erosional fault-line features or shoreline features; this should be taken into consideration during more detailed investigations. The Class III features are shown because we feel they are possibly fault-related and are important enough to be considered for further investigation and evaluation. Our confidence level decreases from Class I to III.

It is important to understand that some minor fault breaks may not have been identified or recognized as they may be easily confused with other topographic features, such as shorelines. Again, this emphasizes the need for more detailed surface mapping and subsurface investigations.

ACCURACY

Fault-related features plotted on the map generally have a lateral

accuracy of ± 100 feet. In areas of high relief or where cultural development such as roads, fence lines, and other similar features are lacking, the accuracy may be no better than ± 200 feet. In urbanized areas, the fault features have been modified and obscured by urban development, and only the most obvious scarps are plotted; more detailed studies are needed to locate the less prominent secondary faults.

PURPOSE OF MAPS

The purpose of these maps is to aid general regional land-use planning. The information presented is intended to provide a framework for more detailed investigations and evaluations.

THE SOUTHERN WASATCH FAULT

The most recent displacements along the Wasatach fault are predominantly vertical, with the mountain block being displaced relatively upward with respect to the valley block. Because of the vertical displacements and the geometry of the fault plane, past movements along the Wasatch fault have produced topographic displacements called graben and tilted blocks adjacent to the main fault break. Future displacements are also expected to produce graben and tilting of adjacent blocks. This tilting should be given serious consideration in locating high-rise buildings or other structures that cannot tolerate tilting or changes in lines of level.

Landslides are common along portions of the Wasatch fault. Several of the largest are noted on the maps. Some landslides are presently active, while others appear to be older and presently in a state of equilibrium. Landslide deposits are important because, even though some do not appear to be moving presently, they are potentially unstable, especially if they are altered or disturbed. Disturbances by earthquakes, fault movements, man-made cuts, or heavy rainfall could re-activate a slide mass.

For the purpose of the present investigation, the southern portion of the Wasatch fault has been subdivided into 13 zones. This zoning does not represent areas of higher or lesser risk, but has been done in order to simplify the following description of surface faulting, which is generally of the same character within each zone but may vary in character for different zones.

FAYETTE TO SEVIER BRIDGE RESERVOIR

Surface faulting between Fayette and Sevier Bridge Reservoir is located along the base of the San Pitch Mountains. The faulting south of Mellor Canyon forms a zone of subdued, roughly parallel

scarps 2,000 feet wide at the widest point near Fayette Springs. Surface faulting north of Mellor Canyon to Sevier Bridge Reservoir appears to be very fresh, indicating very recent surface-fault activity. The zone of faulting north of Mellor Canyon is narrow, consisting of a single scarp in the area near Rough Canyon.

It is very likely that the fault extends south of Fayette toward Rocky Point, west of Gunnison, but surface faulting in this area is very subdued, indicating much older activity than adjacent areas to the north.

SEVIER BRIDGE RESERVOIR AREA

Surface rupturing in the Sevier Bridge Reservoir area is very fresh, complex, and consists of unique features absent from the rest of the Wasatch fault zone.

Surface Fault Scarps

Surface faulting is located on both sides of Flat Canyon. At the base of the San Pitch Mountains, south of Hells Kitchen Canyon, the surface faulting is extremely fresh and appears to cut all but the most recent alluvial deposits. These very fresh scarplets extend south across Highway 28 and then along the Gunnison-Fayette Canal.

On the east side of Flat Canyon, faulting appears less fresh and can be seen in the area where Timber Canyon wash intersects Highway 28. In this area, a large fault scarp within the bedrock of Cedar Ridge extends southward into the wash of Timber Canyon. Other possible fault scarps trend approximately north-south, parallel to the Cedar Ridge scarp but in nearby bedrock.

Surface Ruptures Associated with Ground Failure

The ground surface east of Sevier Bridge Reservoir, in Hells

Canyon and Timber Canyon washes, is shattered by very fresh surface fissures. These surface fissures are marked by vegetation lineaments and by elongated, enclosed depressions. Some of the depressions are as deep as 4 to 5 feet, but generally they are on the order of 1 to 2 feet deep.

The material composing the washes is a poorly consolidated silt which is easily eroded. We feel that these fissures could not be preserved in this type of material for very long, as erosion would obliterate them. This observation, along with the fresh nature of the fault scarps in the area, suggests very recent earthquake activity and surface faulting. The fissures in the vicinity of Cedar Ridge are larger and deeper than those in Hells Kitchen Canyon wash.

These fissures are most likely caused by ground failure phenomena associated with ground shaking and not faulting. Their appearance is strikingly similar to shallow-liquefaction features commonly seen following large earthquakes in other areas. It is very likely that the recent faulting and ground failure were concurrent.

SEVIER BRIDGE RESERVOIR TO NEPHI

Faulting north of Sevier Bridge Reservoir to Nephi is marked by a series of relatively young surface breaks separated by zones that exhibit little or no evidence of past surface fault movements.

Faulting appears fresh from the mouth of Chriss Canyon south to the area of Cedar Ridge, where evidence of surface faulting dies out, only to be found again 1-½ miles east near Timber Canyon. In the area south and west of Skinner Peaks, the most recent faulting is within bedrock, approximately 1/2 mile east of Highway 28. Surface faulting dies out at the mouth of Chriss Canyon, but is found again one mile north at the mouth of Little Salt

Creek, and also 1-1/2 miles north of the mouth of Little Salt Creek, older fault scarps are found intermittently. North of Levan, fault scarps are generally located at the base of the mountains, with most faulting in the bedrock and little faulting observed in the alluvial valley.

The interval from Levan to Nephi contains only a few older scarplets, mostly in the area between the mouth of Four Mile Creek and Cedar Point. No positive evidence of fault scarps was observed between Cedar Point and Nephi.

NEPHI TO SANTAQUIN

Faulting appears very fresh between Nephi and the north end of Juab Valley. In Nephi, relatively fresh surface faulting is marked by vegetation lineaments and a graben on the north side of town. Scarp height generally increases northward to Gardner Creek, where the fault joins the base of the Wasatch Mountains and extends northward to the north end of Juab Valley. The fault zone in this area is typical of Basin-and-Range faulting, hugging the base of the mountains in a narrow zone only a few tens of feet wide. Only on the Mendenhall Creek fan can fresh evidence of faulting be found extending into the valley.

At least five large landslides are found along the base of the mountains in this portion of the fault zone. Four of the landslides are offset by the fault; with the remaining landslides at the north of Juab Valley occurring where the fault dies out. Two of the landslides are associated with failures of the Manning Canyon Shale; another is associated with the North Horn Formation. The landslide at Birch Creek, approximately 4 miles north of Nephi, appears to have flowed out from the mountain range into the valley more than one mile. Large landslides of this type can represent serious hazards to urban development as evidenced by the disasterous debris avalanche which occurred in Peru during the Peru earthquake in 1970 (Cluff, 1971).

SANTAQUIN TO SALEM

The faulting in the bedrock areas of Pole Canyon, Santaquin Canyon, and Payson Canyon is a complex combination of normal faulting and thrusting, mapping in this area is complicated by poor rock exposures and densely forested land.

In general, the fault trends mapped are roughly north-south in bedrock west of Pole Canyon and on the east side of Santaquin Canyon, northeast trends are found between Santaquin and Payson along the southeast margin of Payson Canyon and Loafer Canyon also at the base of the range. Rocky Ridge, immediately southeast of Payson, appears to be fault-controlled, although Lake Bonneville shorelines appear to cross the lineaments undisturbed.

Spring Lake, south of Payson, appears to represent a ponded graben, with a gentle scarplet facing southeast along the northwest margin of the lake; this graben is nearly one mile wide. The possibility of broad tilting within this graben during the next earthquake is an important factor to consider in developing this area.

SALEM TO SPANISH FORK CANYON

In this area, surface faulting is found along the base of the range between Salem and Spanish Fork Canyon. Fault scarps in alluvium generally are large, west-facing slopes along the base of the range, and are generally parallel to Lake Bonneville shorelines. It is likely that the positions of several of the prominent shorelines are controlled by faulting.

SPANISH FORK CANYON TO HOBBLE CREEK

Surface faulting between Spanish Fork Canyon and Hobble Creek is characterized by high, steep scarps, complex graben development, and blocks which have been tilted backward against the main scarps. One such tilted block is located at the mouth of Spanish Fork Canyon.

A large complex graben exists just south of Maple Canyon. This graben is in the process of being converted to a reservoir. The total zone of faulting in this area is wider than 1,000 feet.

At the mouth of Hobble Creek, there exists another large graben which is partly occupied by Burt Spring Pond.

HOBBLE CREEK TO SPRINGVILLE

Surface faulting between Hobble Creek and Springville is marked by large fault scarplets facing southwest, along the base of the range. A series of springs on the eastern side of Springville (Fullmer Spring, Clyde Spring, Wheeler Springs, and other springs to the north) may mark the locations of other fault traces away from the base of the range.

A prominent fault, herein termed the Springville fault, leaves the rangefront east of the State Fish Hatchery and strikes southwestward through the west side of Springville at least to the corner of 300S 400 W; it is very likely that the fault continues farther south, but it has not been traced farther because of limited coverage of special low sun-angle aerial photography. The possibility that other faults extend into the valley in the same manner as the Springville fault should certainly be considered further. Our limited photography precluded such a consideration for this study.

SPRINGVILLE TO IRONTON

The zone of geologically recent surface fault ruptures from Springville to Ironton is relatively broad, possibly being 1/2 mile or more in width. Fault scarps are prominent upon the relatively steep slopes between the base of bedrock exposures and the level valley floor.

Ground ruptures associated with soil failure are also found in this section. A fresh graben reaching a maximum depth of 11 feet is located near the Ironton slag dump and intersects a second graben of similar age. These graben may be a result of soil failure.

IRONTON TO ROCK CANYON

The fault segment between Ironton and Rock Canyon exhibits large, west-facing scarplets along the base of the range, and small scarplets along alluvial fans near the range front. Several active fault traces and graben are located in the residential area immediately south of Rock Canyon, but only one trace is prominent within the alluvium of Rock Canyon. Active fault traces pass under numerous residential dwellings near Rock Creek and under the Provo City water tank north of Slate Canyon. Extensive faulting passes behind the State Mental Hospital which appears to be situated on a large block which has been tilted as a result of past earthquakes. A future large earthquake with surface faulting may have extremely severe consequences in this section of the fault zone.

ROCK CANYON TO PROVO CANYON

Recent-appearing fault scarplets die out approximately two miles north of Rock Canyon, and the zone of surface ruptures broadens into a zone as wide as one mile, extending from the base of the range eastward into the mountains. Several fault segments within the mountains represent intact blocks of rock bounded by faults; these blocks are termed *"horses."*

PROVO CANYON TO ALPINE

The fault segment from Provo Canyon to Alpine consists of a series of *"horses"* in the bedrock, with relatively few recent fault scarps developed between Provo Canyon and the area around American Fork Canyon. However, a segment of recent fault scarps

does extend along the base of the range from approximately two miles south of American Fork Canyon to Chipman Canyon, north-east of Alpine. The fault is marked in this zone by springs, well-developed scarplets, and graben. The fault zone turns from nearly north-south at Box Elder Canyon to nearly south-west to Chipman Canyon, where the fault zone forms the boundary of the Wasatch Range with the Traverse Mountains.

ALPINE TO CORNER CANYON

The zone of recent surface fault ruptures in this segment is not as well defined as it is on either end, at Corner Canyon to the west and Chipman Canyon to the east. In general, the zone of surface faulting coincides with the base of the steep front of the Wasatch Range. Slope stability may be poor in the Traverse Mountains, and, thus, fault scarps may be masked by more recent landslides and slope movements.

METHODS OF EVALUATING FAULT-RISK PROBLEMS

The fault-risk problem is not a simple question of either designing for complete protection or ignoring the risk altogether. From the point of view of society, neither of these alternatives is acceptable. To establish an acceptable, efficient and practical solution requires a significant amount of knowledge about the Wasatch fault and the potential effects of the fault on works of man.

The most recently active portion of the Southern Wasatch fault has never before been sufficiently mapped nor its exact location and extent known. Accurate determination of the Wasatch fault and full evaluation of its significance can only be accomplished by extensive geologic studies, geodetic studies, seismic studies and other special studies such as drilling and trenching. The geologic investigations should be followed by interdisciplinary evaluations involving geology, engineering and planning.

A comprehensive investigation for siting a structure to fully determine the exact location and significance of all active fault features and related hazards should entail the following steps:

Step A: Preliminary Regional Geologic Investigation and Evaluation - (this is the scope of this report).

(1) Review of Existing Knowledge, including review of existing literature, maps, aerial photographs, and consultation with experts.

(2) Aerial Field Orientation, including aerial reconnaissance at both high and low altitude to reveal both synoptic and detailed features.

(3) Special Low Sun-Angle Aerial Photography at various scales (1:6000-1:24000).

(4) Field Study following preceding steps.

(5) Synthesis of Results.

(6) Preliminary Report should include results of above steps and recommend any additional necessary studies.

Upon completion of the above, sufficient preliminary information exists to establish regional land-use planning guides. This method allows urban development to proceed on a regional basis, while indicating the locations of potential hazards so that more detailed investigations can be undertaken to more fully evaluate their magnitude, extent and significance.

Step B: Detailed Investigations and Evaluation

(1) Detailed aerial photo interpretation.

(2) Detailed field mapping.

(3) Preliminary subsurface investigations, including geophysical methods (seismic refraction, magnetic, gravity and resistivity); and selected trenching and drilling.

(4) Evaluation of fault-related features in conjunction with structural engineering considerations.

(5) Preparation of fault risk-zone and a corresponding guide to land-use planning, taking into consideration (a) type of occupancy or land-use, (b) type of construction, (c) structural systems and height which will house the occupancy.

Upon completion of Step B, sufficient information will exist to determine the feasibility of certain types of land-use and building occupancy. The next step may warrant even more detailed investigations and evaluations of sites for specific land-use of building occupancy, such as hospitals, emergency services, and high occupancy structures.

Step C: Detailed Site Investigation and Evaluation

(1) Detailed extensive subsurface investigations utilizing mainly trenching and drilling.

(2) Detailed structural engineering evaluation.

Upon completion of Step C a specific site or proposed land-use could be fully evaluated from all aspects of active faulting and fault-related seismic hazards.

Ideally, the above investigations and evaluations (Steps A through C) should be completed along the entire Wasatch fault if high-density urban development is desired; however, at the present, this study is limited to Step A, "Preliminary Regional Investigation and Evaluation" of the southern portion of the Wasatch fault.

Before any development proceeds complete investigations as outlined above should be undertaken.

CONCLUSIONS

1. The Wasatch fault is part of a zone of active faults extending from southern Utah into Idaho and Montana. This zone has been associated with strong earthquake activity in the past and major earthquakes are expected in the future. Significant fault displacements are anticipated along the presently known active faults.

2. Generally the risk from surface faults actually passing through a structure is low, however approximately 90% of Utah's population is located within or along the active Wasatch fault zone, significantly increasing the risk from surface faulting and other related earthquake hazards.

3. The Wasatch fault is considered active on the basis of geologic and seismologic evidence. The landforms along the Wasatch fault exhibit features typical of recently active faults.

4. The Wasatch fault will generate large earthquakes in the future, many of these earthquakes may be accompanied by surface faulting. Structures located astride the faults will be torn apart in the event of future fault displacement.

5. It is probable that future fault displacements will follow the most recently developed planes of weakness. The most likely locations for future major surface fault ruptures are along lines marked on the accompanying maps as Class I. Minor displacements due to branch or splinter faulting, or ground failure, will most likely occur along Class II and Class III lines.

6. Vertical deformation may take place as a result of fault displacement. Such deformation may uplift, depress, or tilt the land surface for considerable distances, as much

as several hundred feet on either side of the causative fault. This tilting should be considered by local governments in planning and zoning stages as a definite hazard, especially to multi-story or high-rise construction.

7. Aside from surface fault rupture, the area may be subjected to other earthquake effects such as strong shaking and ground failure. These effects are directly related to the intensity of shaking and the response of the foundation soils to the earthquake vibrations. In this regard, the proximity of a particular site to an active fault is not as important as the ground conditions beneath the site, provided the site is not astride an active fault trace. Therefore, it is possible to have a site located near an active fault that may be safer than a site having poor soil conditions located several miles from the fault.

8. Numerous landslides exist along the Wasatch Range Front coincident with the Wasatach fault zone. An earthquake of the size which is capable of occurring could cause landslides and rock falls of large proportions, primarily affecting the areas adjacent to the Range Front. Where these hazards exist, land development should be controlled by governmental zoning agencies.

9. Faulting has been found extending into areas not covered by our photography, and there is a possibility that other active fault traces exist outside the area of this investigation.

The opinions and conclusions set forth in this report and the resulting recommendations attempt to set guidelines for general regional land-use planning near the Wasatch fault in order to avoid the most dangerous areas and to minimize potential damage during a major earthquake.

RECOMMENDATIONS

Before private or public development is allowed to continue along the Wasatch fault, comprehensive geological and engineering investigations and evaluations should be required. These investigations should define the exact locations of surface fault ruptures and other geologic hazards on or near the proposed development. Once these features have been defined accurately, an estimate should be made, with appropriate supporting data, as to the extent and magnitude of displacement that should be anticipated for design purposes. The rapid urbanization along the fault zone on the foothills in the Utah County area of this study should be given immediate consideration for detailed field mapping and land-use zoning.

Attention should be given to evaluate overall site stability to assure that a site can be expected to remain substantially intact during and subsequent to the design earthquake or fault displacement. Although some cracking of the ground and cracking of pavements might occur, it should be expected that there would be no large fissures, offsets, or lateral movements or vertical slide movements of more than a few inches.

In evaluating the landslide potential, as well as locations of soil strata which might be subject to reduction of strength or liquefaction, it is recognized that complete certainty in the locations of such strata and in the evaluation of behavior during an earthquake is not practically feasible. Therefore, the studies should be carried to a degree of thoroughness which would indicate a high order of dependability of the overall conclusions. The recommendations reached should include an appropriate evaluation of the limits of confidence which might be expected, based on the extent of the studies made.

Schools, hospitals, emergency services, and other buildings of high socio-economical importance should not be built astride earthquake faults. High-pressure transmission lines such as water,

gas, petroleum, chemical, and other volatile products should avoid crossing the Wasatch fault if possible. Where these transmission lines must cross the fault, they should do so at or near the ground surface and at right angles to the strike of the fault. They should incorporate such safety features as flexible joints and automatic shutoff valves to be activated immediately if the lines are damaged by fault movement or earthquakes.

Contingency plans to be followed in the event of a large earthquake should be drawn up. It is important that recovery and reconstruction operations do not duplicate or create new disaster situations. Examples from other states would be useful in this regard.

A highly competent Review Board should be implemented and charged with the responsibility of evaluating the appropriateness of specific investigations and analyses which may be required for any particular land use or project. The appropriate scope and extent of such investigations and studies should be sufficient to enable the knowledgeable professional geologists, engineers, and other specialists on the Board of Review to ascertain that the severity of each particular type of problem has been reasonably evaluated, and the margins of safety provided are appropriate in relation to the particular problem under consideration. It is expected that, as work is carried on under this program, there will develop a sound body of information concerning investigative and design and construction procedures which will enable desirable projects to be carried out with an optimum balance between the factors of cost, risk, and function, and that this can be accomplished while encouraging a continued improvement in the "state of the art" regarding application of technical knowledge to advantageous use of the properties concerned.

The responsibility of the Board should be as follows: 1) to establish and revise safety criteria for the Wasatch fault and structures therein with respect to risk zoning; 2) to review all proposed development projects for the adequacy of their specific safety criteria and to make recommendations concerning these criteria; 3) to gather and make available data developed from specific projects under their jurisidiction; and 4) to complement the functions of local building departments and local city and county planning departments.

The organization of the Interdisciplinary Consulting Review Board should consist of an equal number of geologists, soil engineers, and structural engineers. An architect and a planner should also be on the Board. Of the total membership, no more than half of the members should have principal employment in one of the following fields: 1) private employment, 2) academic employment, and 3) governmental employment. The Review Board should have adequate authority from either state code or local ordinances to give meaning to their actions.

Adequate legislation pertaining to fault zone hazards, particularly relating to schools, hospitals, emergency services, high-occupancy structures, and subdivisions should be introduced on a statewide and local level. Examples of such earthquake legislation from California is presented in Appendix B.

Building code standards should be related to fault zone problems established or recognized in this report.

In view of the many different uses which may be planned for land areas along the Wasatch fault and the variations in the geologic, soil, and foundation problems which require consideration, it is not feasible at this time to prescribe specific investigations,

tests, or analyses which would be appropriate for all of these varied requirements. The object of the foregoing discussion, therefore, has been directed toward outlining the nature of the problems which might require consideration in any specific land use.

It is recommended that similar investigations and evaluations be completed for critical areas not covered by this or our previous investigation.

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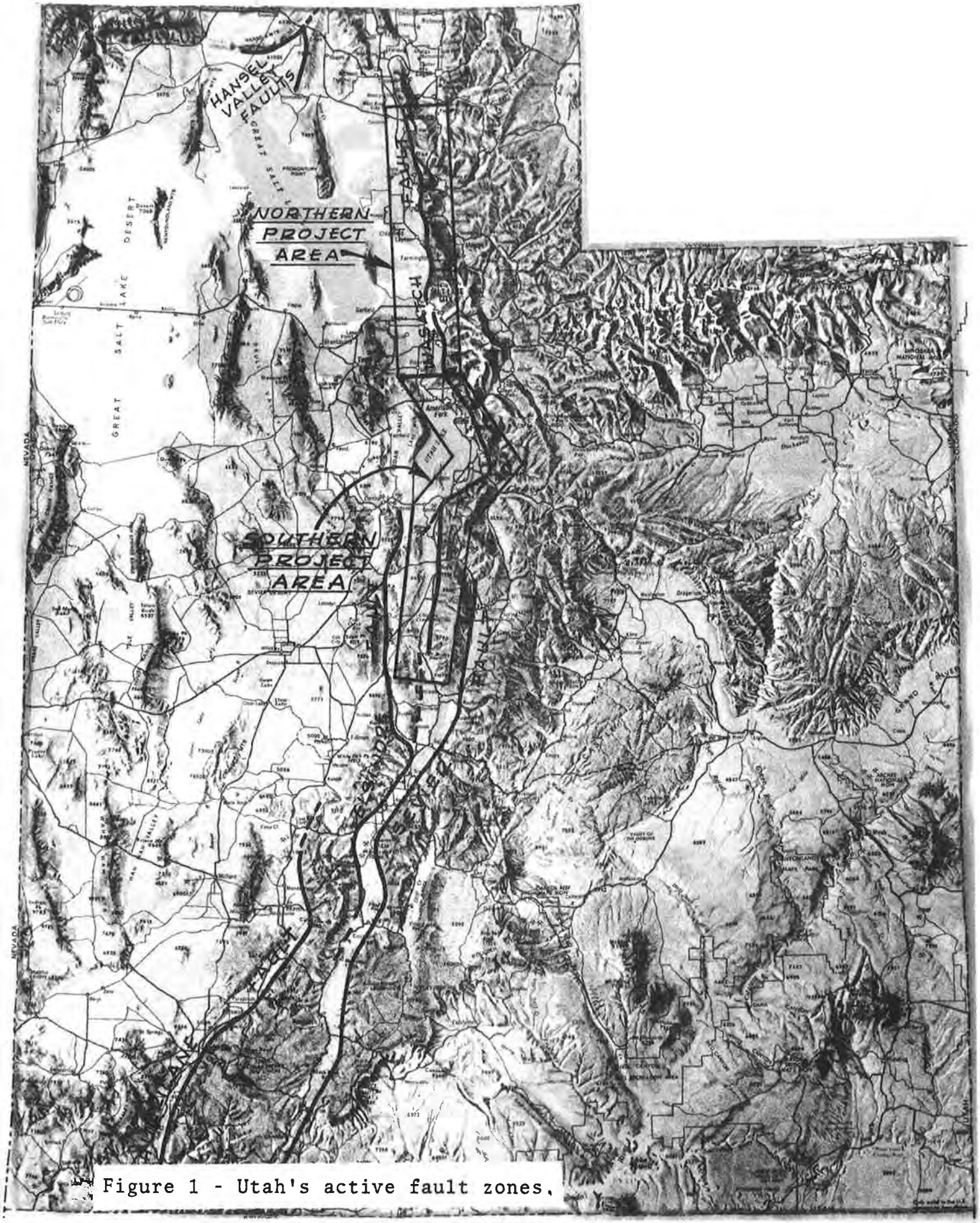

Figure 1 - Utah's active fault zones.

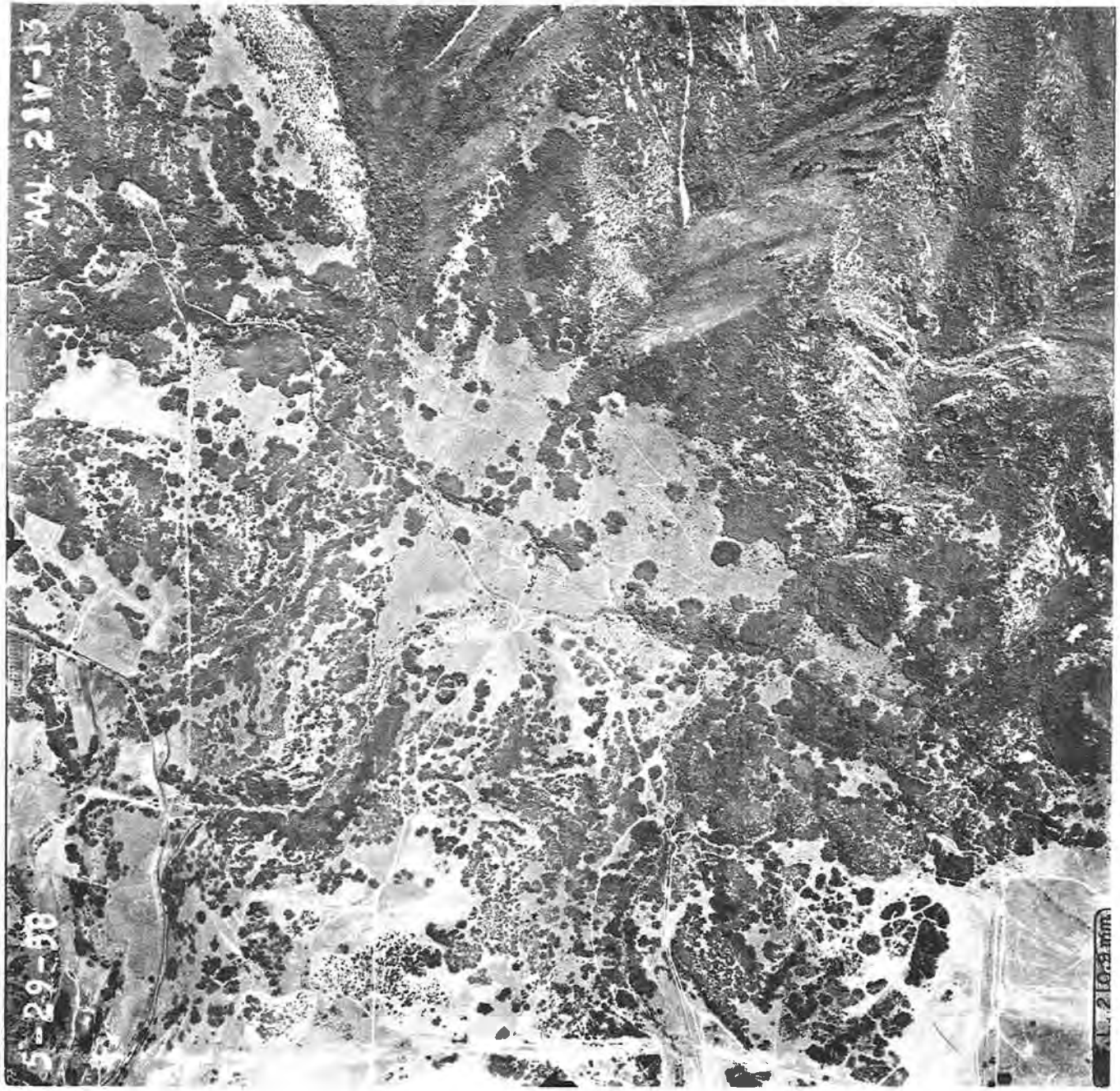

Figure 2 - Conventional vertical aerial photograph of the Wasatch fault south of Bells Canyon. Approximate scale 1:10,000.

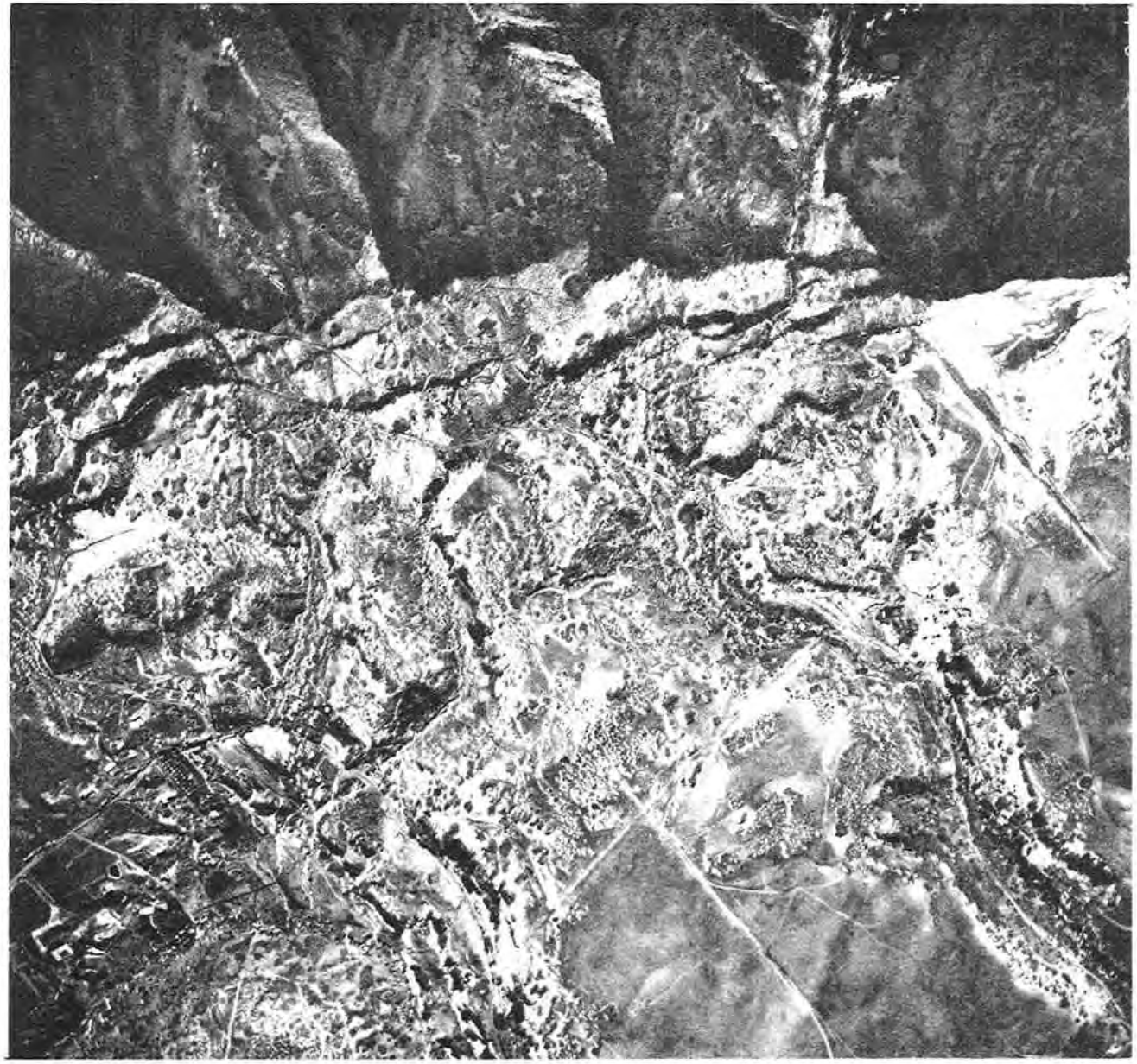

Figure 3 - Low sun-angle vertical aerial photograph of the same area as figure 2. Approximate scale 1:12,000.

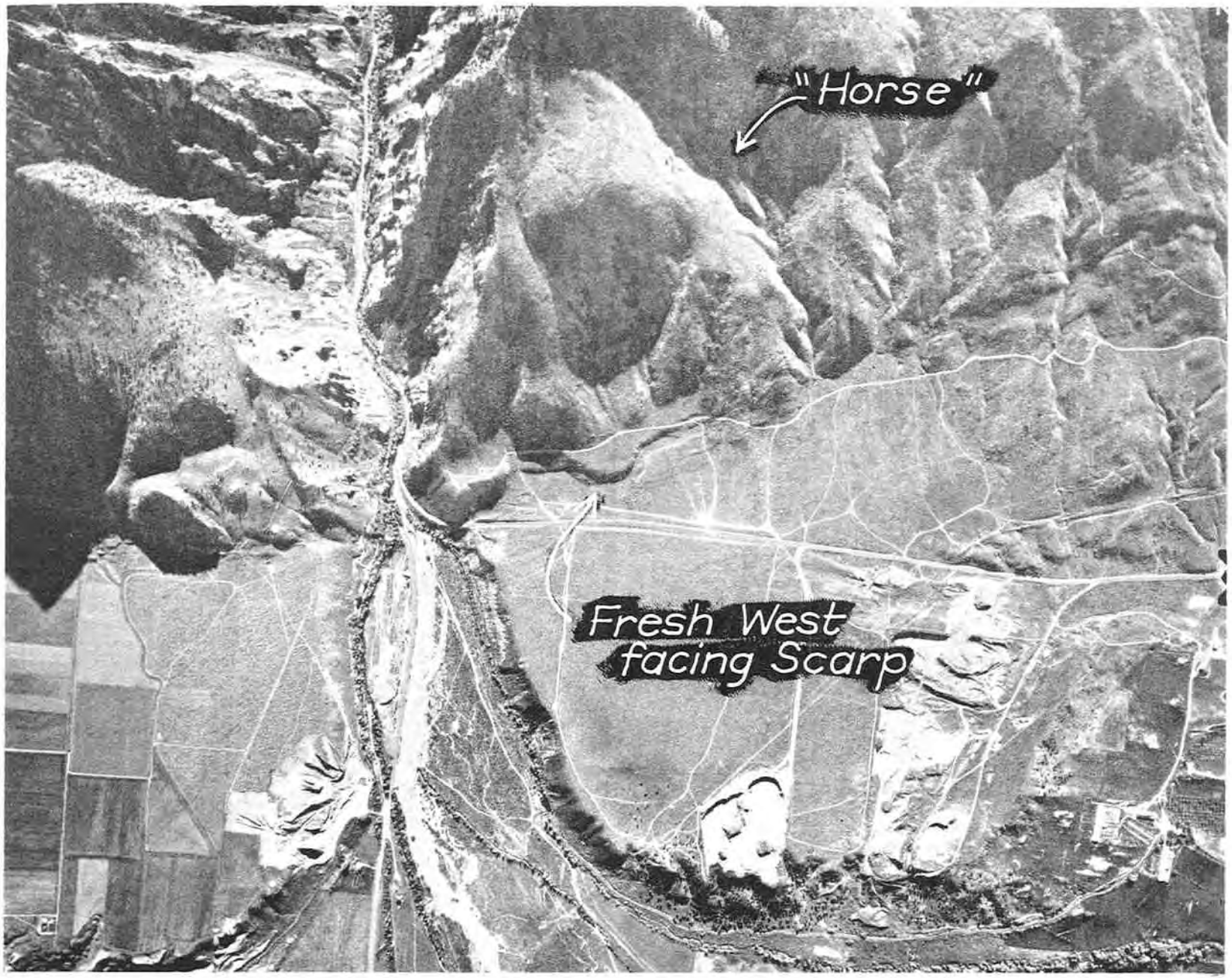

Figure 4 - Vertical aerial photograph looking eastward, showing faulting near American Fork Canyon, north of Provo. Approximate scale 1:12,000.

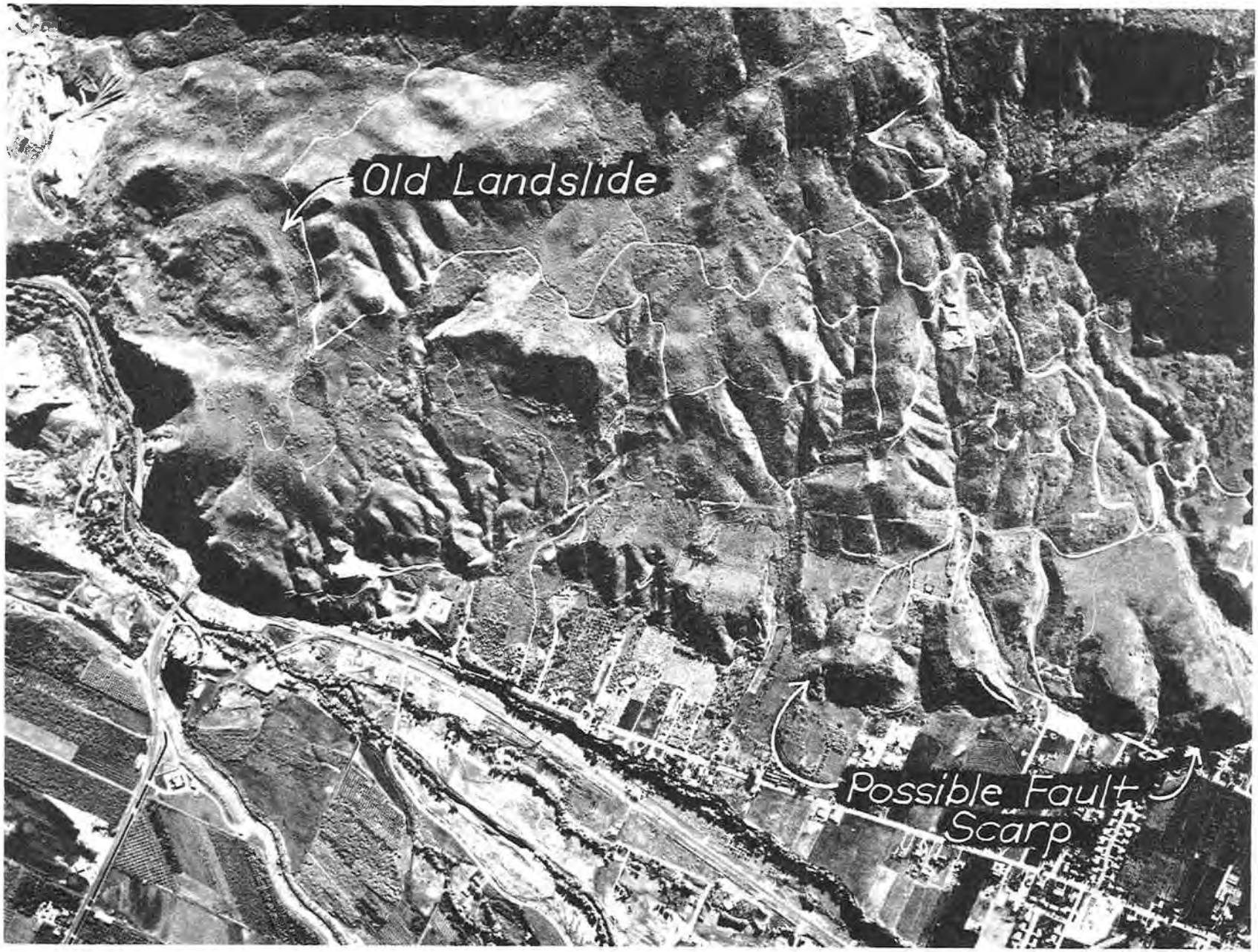

Figure 5 - Vertical aerial photograph showing faulting and landslides south of Provo Canyon. Approximate scale 1:12,000.

Figure 6 - Vertical aerial photograph of faulting through subdivision south of Rock Canyon. Approximate scale 1:12,000.

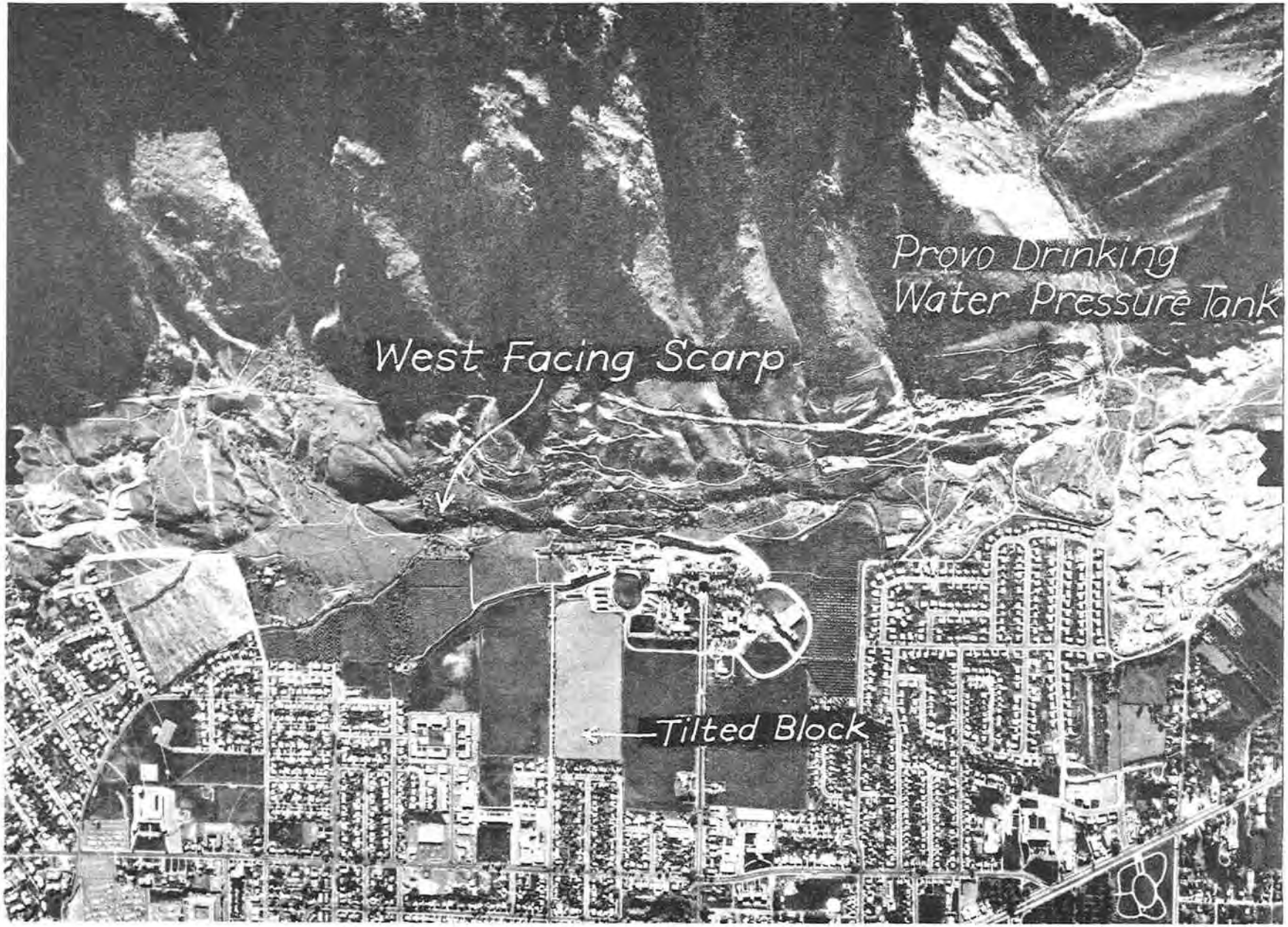

Figure 7 - Vertical aerial photograph showing faulting in back of State Mental Hospital, and Provo City drinking water pressure tank. Approximate scale 1:12,000.

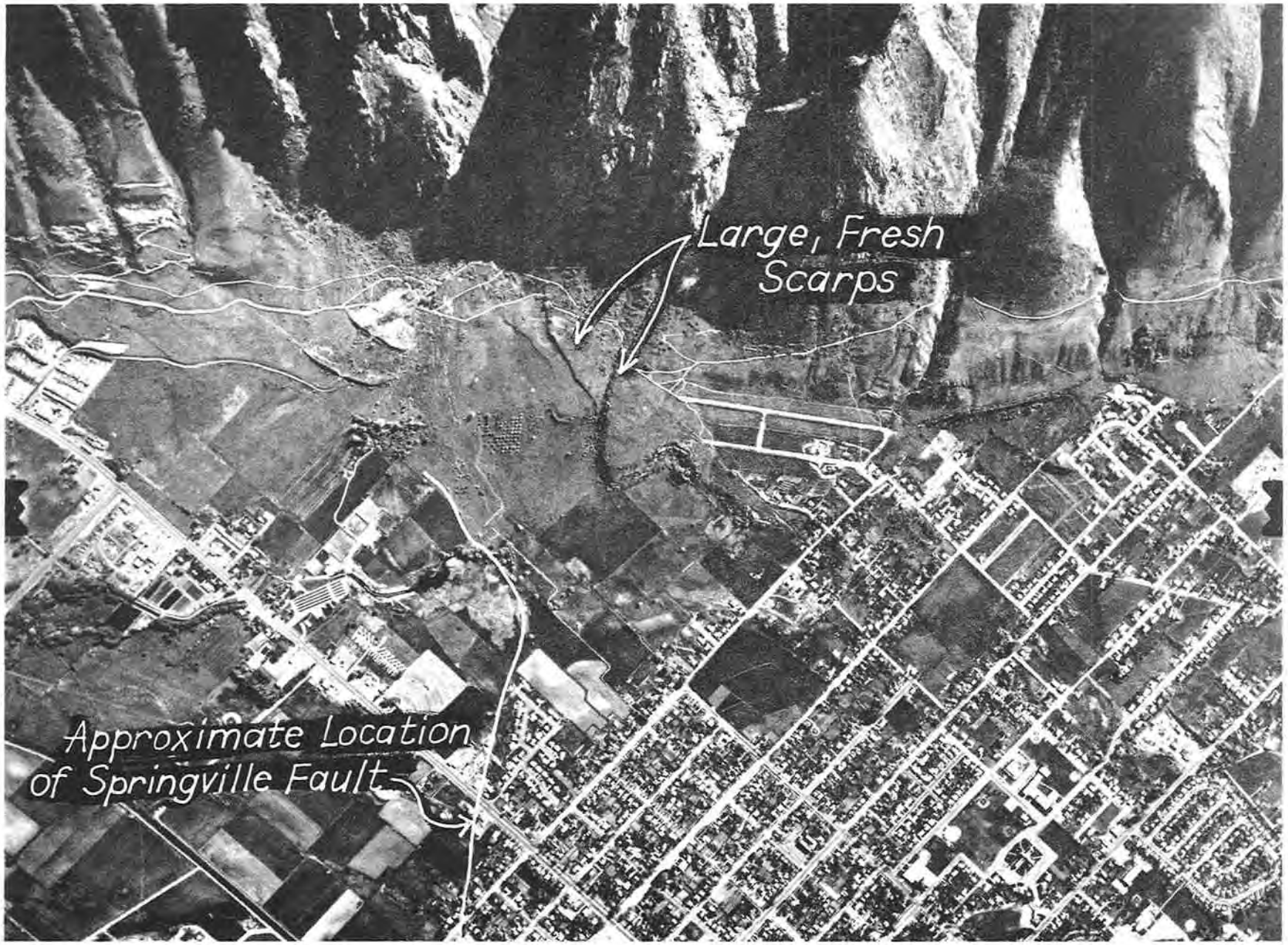

Figure 8 - Vertical aerial photograph showing faulting in Springville. Approximate scale 1:12,000.

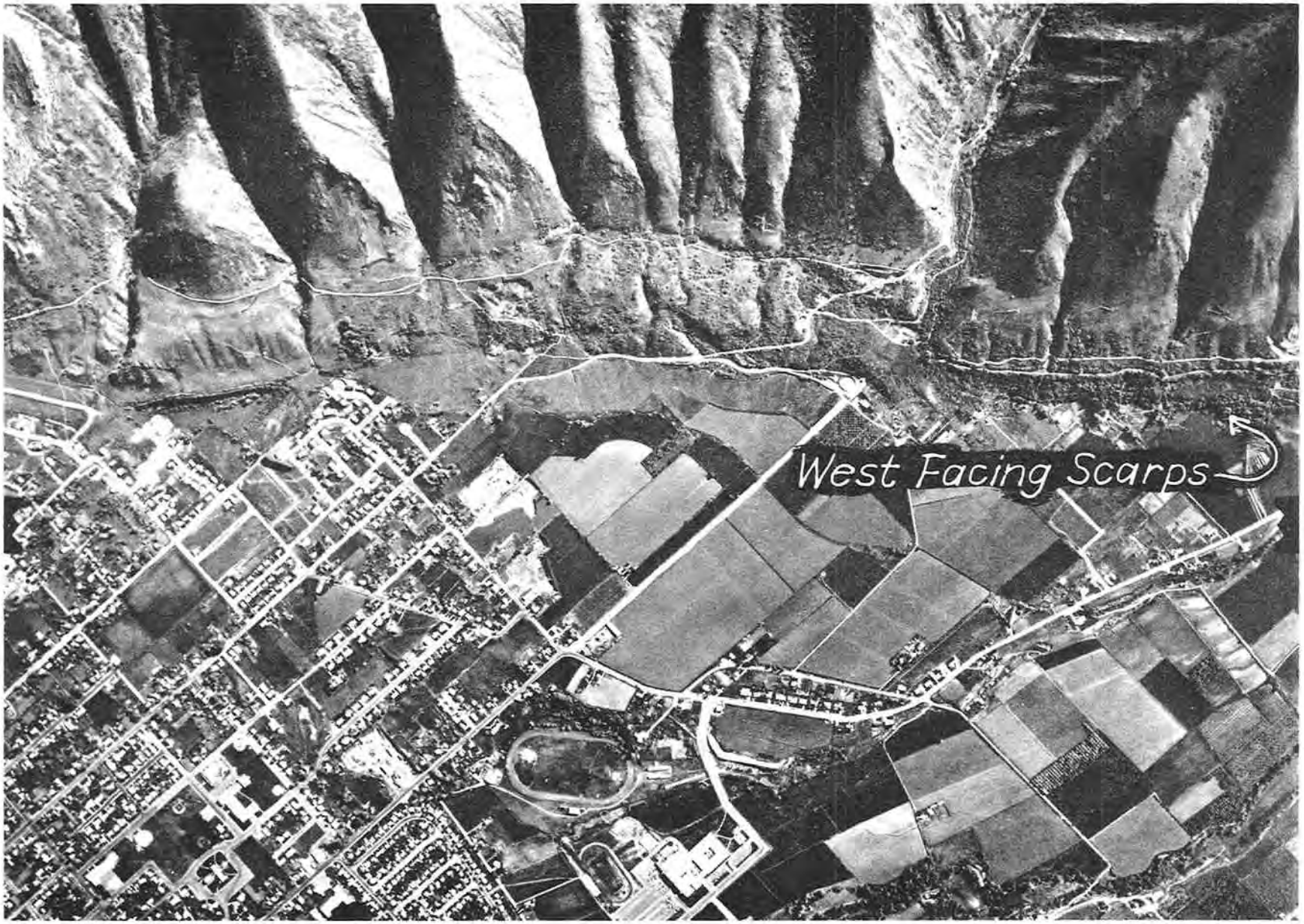

Figure 9 - Vertical aerial photograph showing faulting between Springville and Hobble Creek Canyon. Approximate scale 1:12,000.

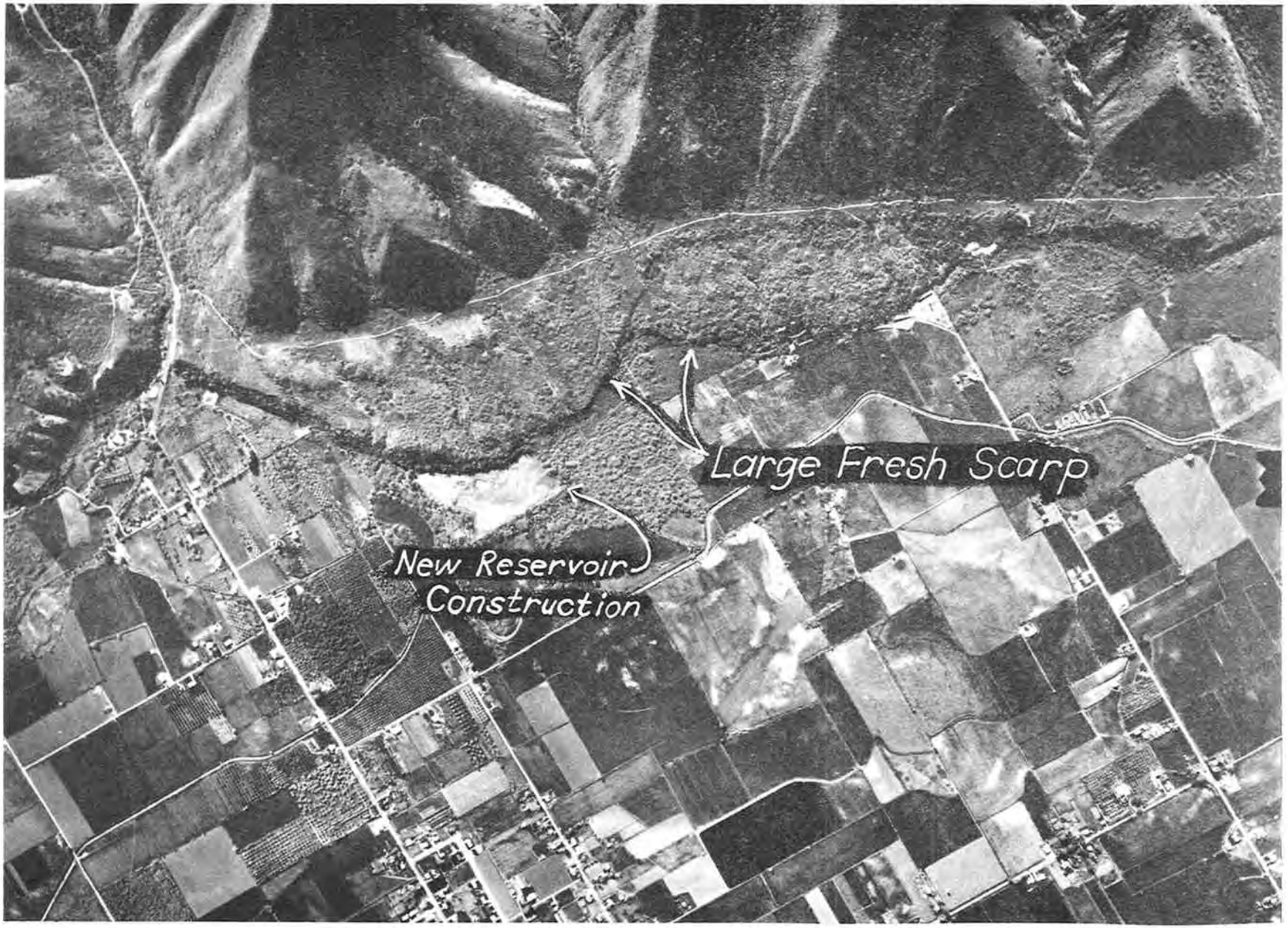

Figure 10 - Vertical aerial photograph showing faulting through new reservoir construction south of Maple Canyon. Approximate scale 1:12,000.

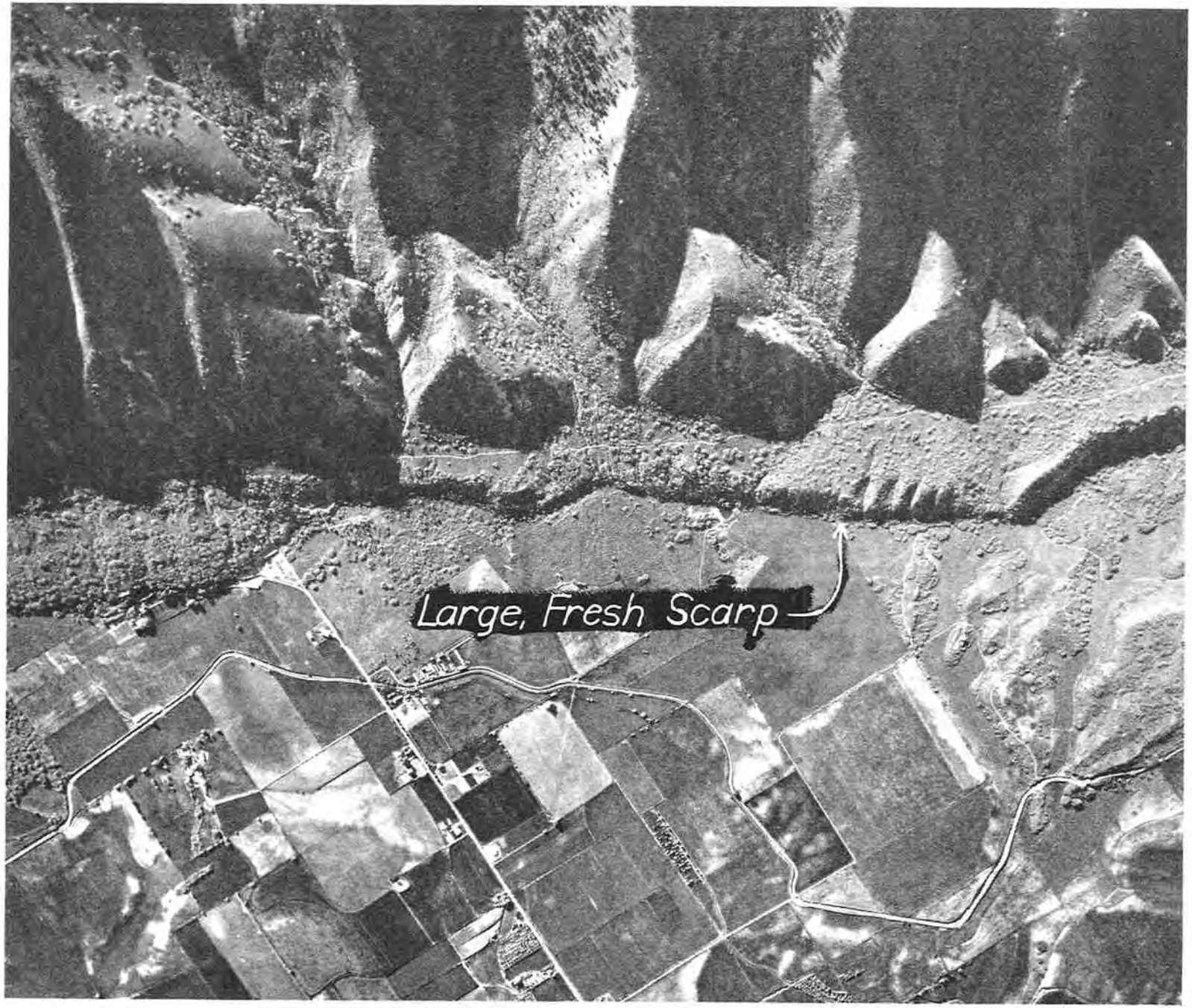

Figure 11 - Vertical aerial photograph showing faulting between Spanish Fork Canyon and Maple Canyon. Approximate scale 1:12,000.

Figure 12 - Oblique aerial photograph showing faulting between Spanish Fork Canyon and Hobble Creek Canyon looking northeast.

Figure 13 - Vertical aerial photograph showing faulting south of Spanish Fork Canyon. Approximate scale 1:12,000.

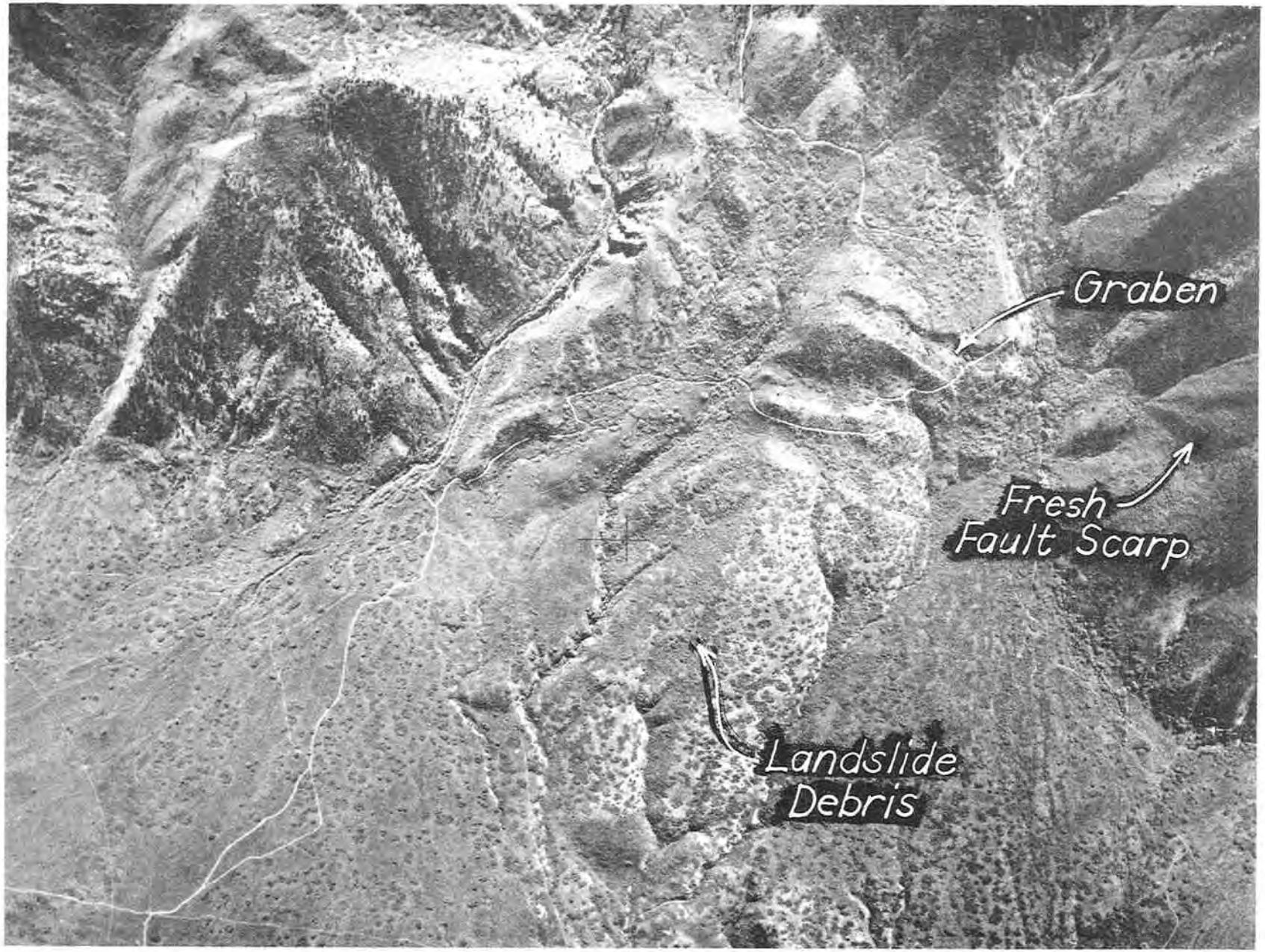

Figure 14 - Vertical aerial photograph showing faulted landslide at Mendenhall Creek Canyon, south of Santaquin. Approximate scale 1:12,000.

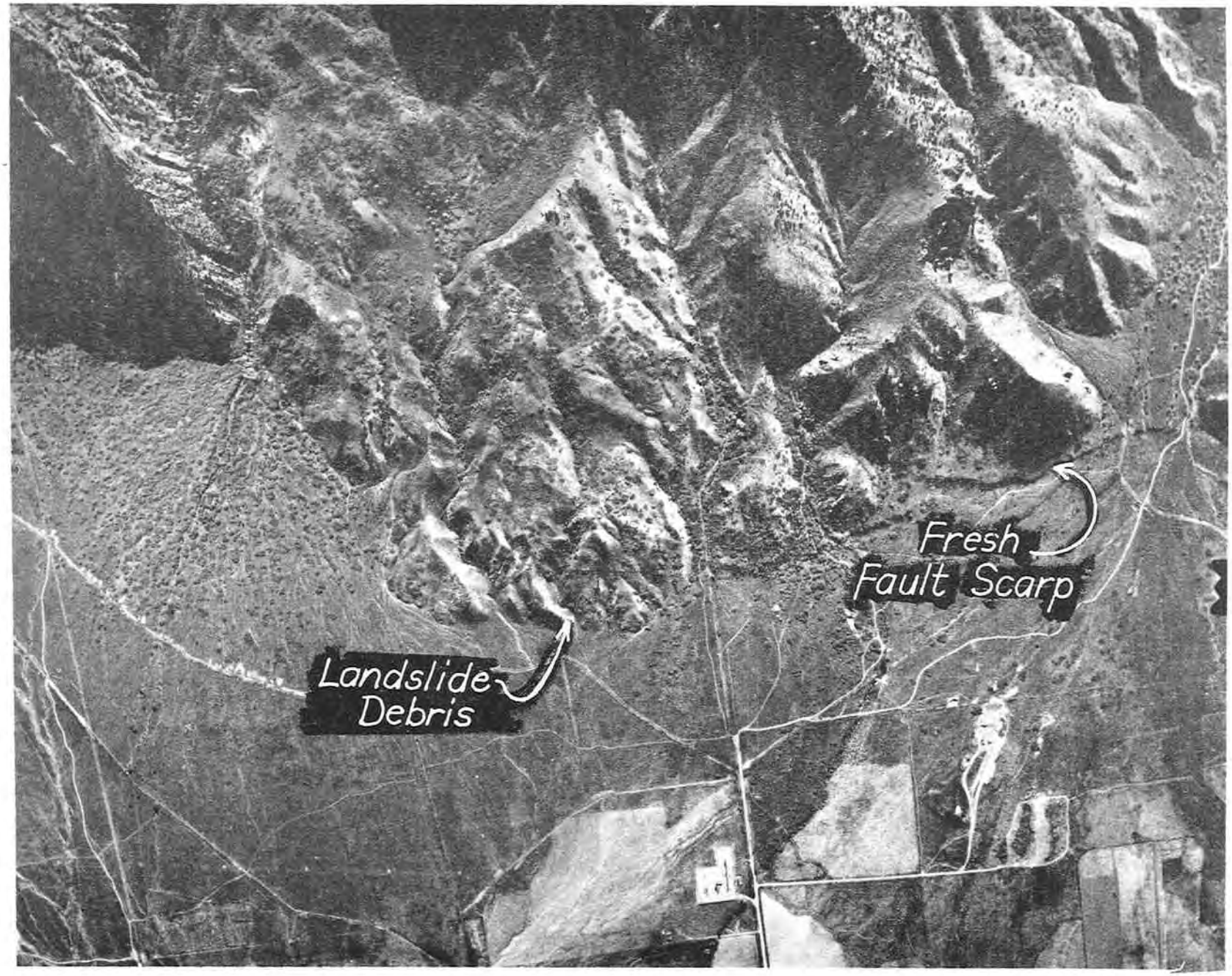

Figure 15 - Vertical aerial photograph showing faulted landslide at Willow Creek Canyon near Mona. Approximate scale 1:12,000.

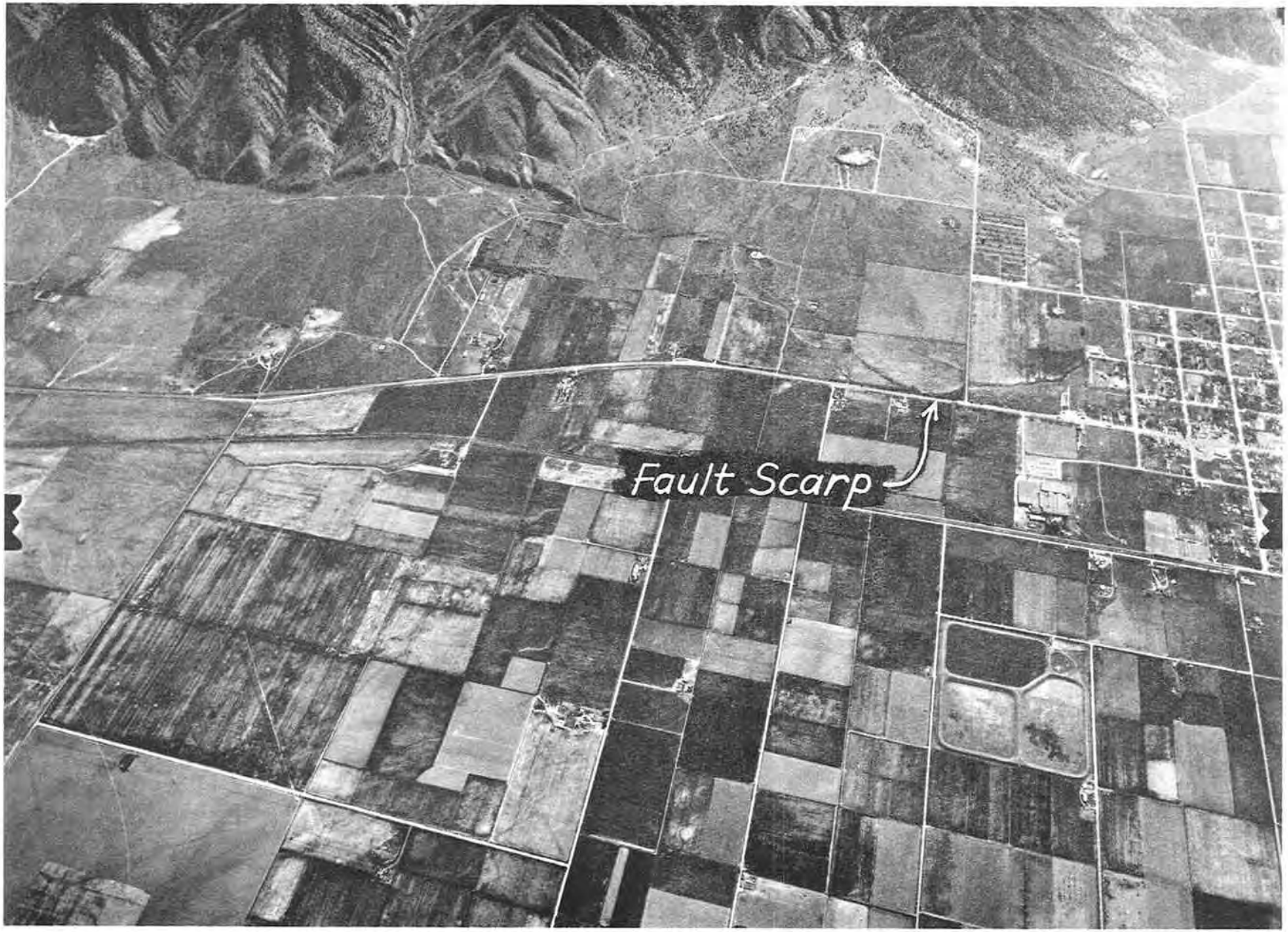

Figure 16 - Oblique aerial photograph looking east at faulting north of Nephi.

Figure 17 - Vertical aerial photograph of faulting shown in figure 16. Fault traces trend into Nephi. Approximate scale 1:12,000.

Figure 18 - Vertical aerial photograph showing faulting south of Skinner Peaks. Approximate scale 1:12,000.

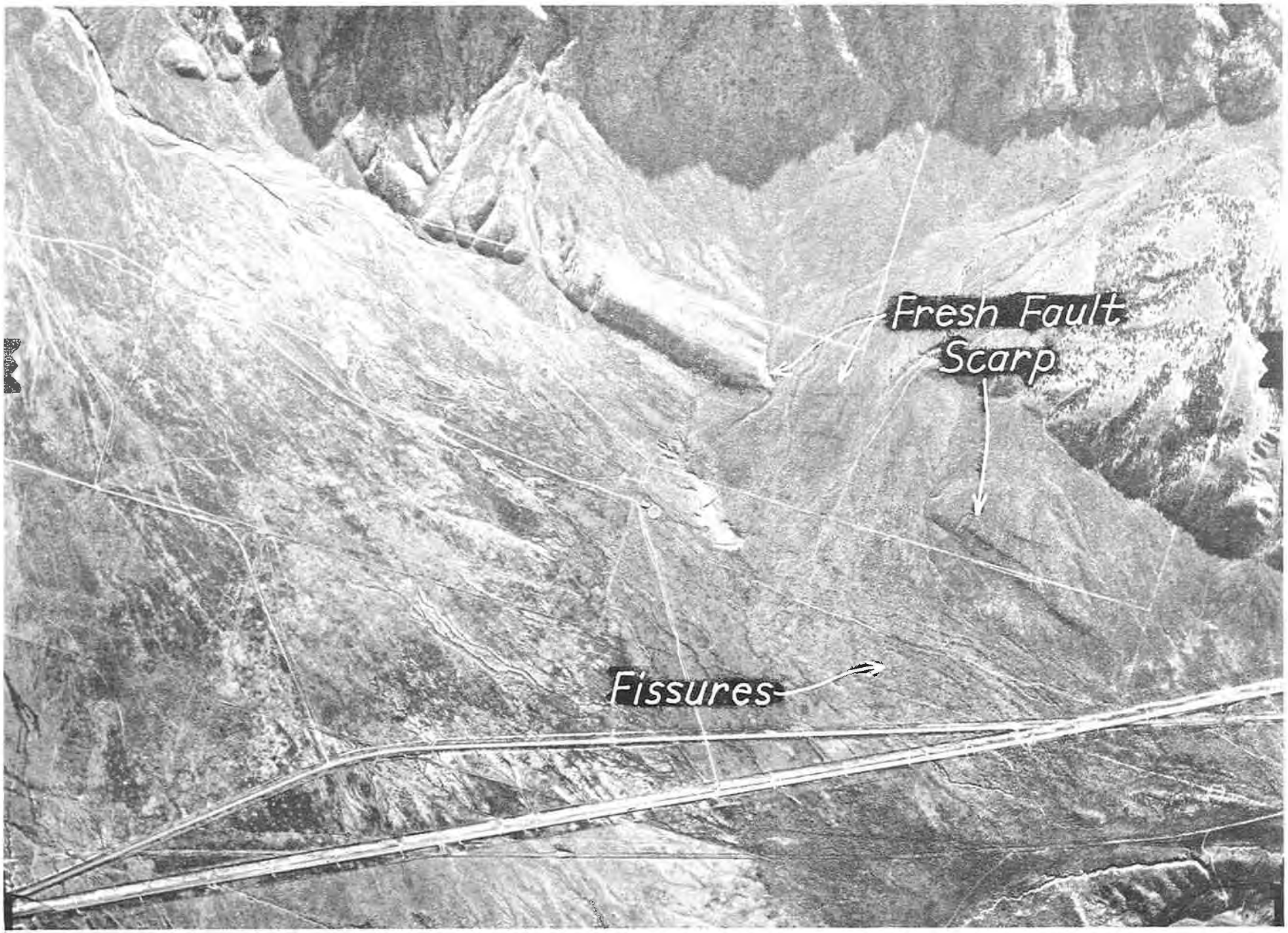

Figure 19 - Vertical aerial photograph showing fresh faulting and fissuring at mouth of Hells Kitchen Canyon. Approximate scale 1:12,000.

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APPENDIX A

GENERAL DISCUSSION OF EARTHQUAKES AND FAULTING

GENERAL STATEMENT

The following discussion is given primarily for persons not familiar with active faults and earthquake related problems. We encourage such individuals to read and study this discussion to ensure a common understanding.

WORLD-WIDE SEISMICITY AND CAUSES OF EARTHQUAKES

While small earthquakes occur widely over the surface of the Earth there are certain regions where large to moderate earthquakes occur frequently. The greater part of the ocean basins are devoid of earthquakes as are Antarctica and the relatively stable Pre-Cambrian shields of Africa, India, Siberia, Australia, Canada, and Brazil. Earthquakes marginal to these shield areas do occur however; for example, the 1663 St. Lawrence Valley earthquake and the 1968 Western Australia earthquake (magnitude 6.9) which partly wrecked the town of Mekering.

The most dense occurrence of earthquakes is found in the Circum-Pacific belt around the margins of the Pacific Ocean, and the Alpide belt, that traverses a comparatively broad area including the East Indies, the Himalayas, Iran, Turkey, and the Balkans. Highly localized concentrations of earthquake *foci* as shown in Figure A-1 also occur along the world-encircling system of mid-oceanic rises such as the Mid-Atlantic ridge and the East Pacific ridge. Whenever there are ocean trenches such as off the Aleutians, Japan, Chile, and Tonga-Kermadecs, and the eastern Carribean, there are earthquakes. The location of these zones of high seismic activity is shown in Figure A-1. This seismic map indicates those places where tectonic forces are now actively deforming the crust of the Earth. It should be noted that, on a global scale, California seismicity along the San Andreas fault system is an extension of the activity on the East Pacific Rise extending northward from the Gulf of California. The strong concentration of seismic activity trending from Southern Utah, bisecting Utah, and into Idaho and Montana is known as the Western Rocky Mountain Seismic Belt. This belt of seismic activity trends along the north-south boundary between the Rocky Mountain-Great Basin-Colorado Plateau physiographic provinces.

When the mechanical properties of the sources of world-wide earthquakes are studied in detail a great deal of variation is found. Not only does the size of earthquakes (in terms of energy released into seismic waves) vary enormously as shown in Figure A-2, but also the depth of the source of the waves ranges from

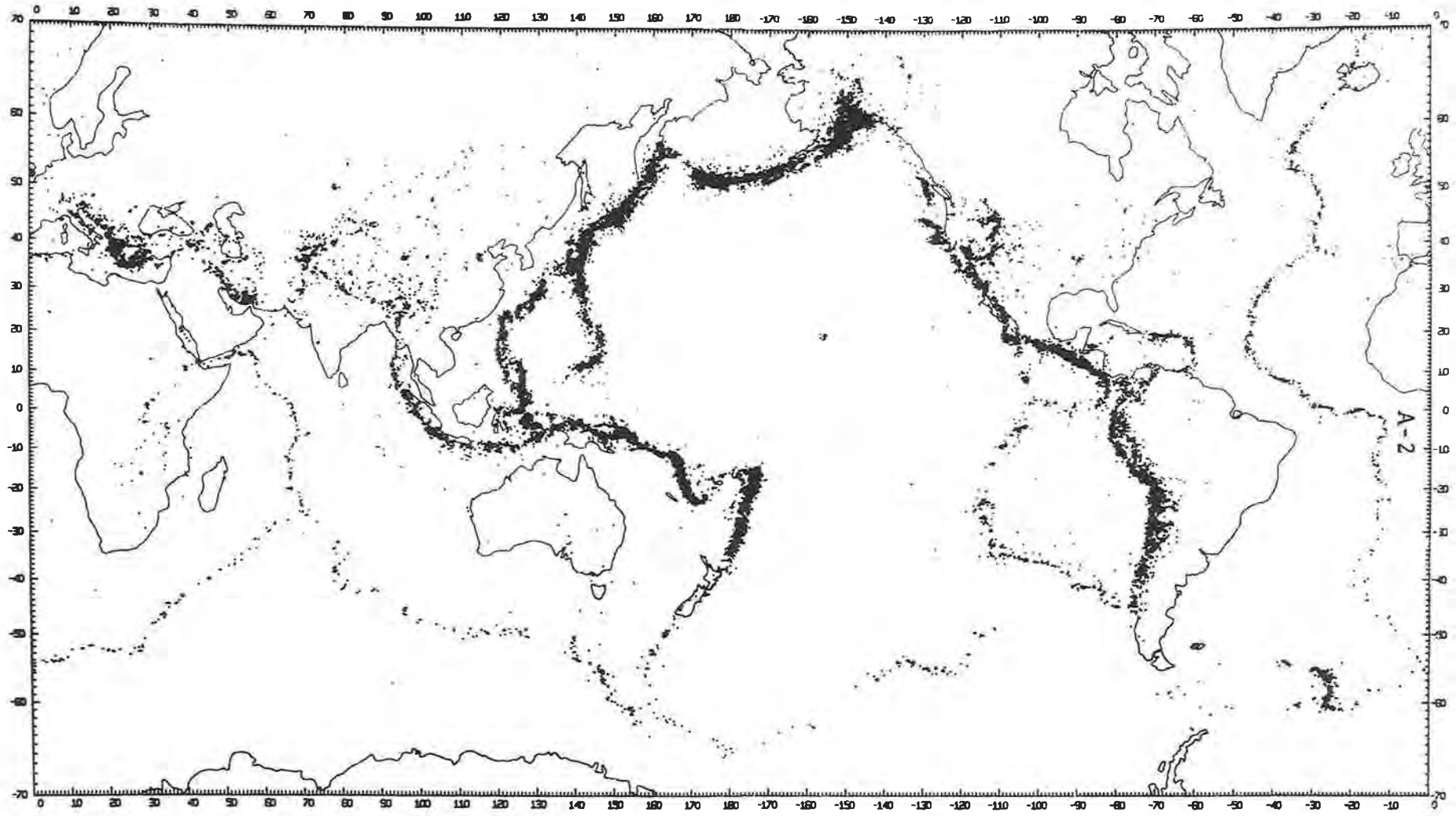


FIGURE A-1. Earthquake zones of the world. World-wide distribution of all earthquake epicenters (1961 through 1967).

near the Earth's surface (less than 10 miles) to depths of 450 miles or so. Earthquakes are often classified as *shallow*, *intermediate*, and *deep*. From the standpoint of earthquake risk, shallow earthquakes can be taken as those originating at a depth of less than about 40 miles. Deep shocks are those below about 200 miles. Deep-focus shocks are almost entirely restricted to a few regions such as Indonesia, Tonga, Japan Sea, and South America. Frequency of occurrence, as a world average, decreases rapidly with depth; over three-quarters of the average seismic energy released is due to shallow-focus earthquakes. Even when geographically near to developed areas, deep shocks are rarely destructive, one reason being that the source of the seismic waves is over 40 miles from the ground surface so that the wave amplitude is greatly attenuated. Another reason is that deep sources are not efficient generators of the seismic waves which travel only through the uppermost rocks of the Earth ("surface waves") and cause most of the sustained ground motion; nor do they generate *tsunamis* ("seismic sea waves").

Recent precise work in California and other parts of the western United States has indicated that earthquake foci along the coastal regions are not generally deeper than 9 miles in the crust and most are no more than 5 miles deep. The 1906 California earthquake was probably associated with a rupture no deeper than 10 miles over most of the ruptured-fault length. The 1811-1812 New Madrid, Missouri earthquakes also probably originated in the crust and there is no evidence that the great 1964 Alaskan earthquake was associated with a rupture deeper than 40 miles. It should be noted, however, that even in the class of shallow-focus earthquakes, variations in focal depth are often sufficient to produce rather different surface effects. For example, the focus of the 1965 Seattle earthquake of April 29 (Richter magnitude 6-3/4), like many earthquakes in the region of the Puget Sound, had a depth of about 30 to 40 miles. As a consequence of the depth, the earthquake was felt widely but damage was only moderate with only a few deaths and about $12,000,000 damages estimated by the Washington State Civil Defense Department. This magnitude exceeds that of the 1933 Long Beach earthquake (magnitude 6.3) whose focus was probably at less than 10 miles in depth; it caused 120 deaths and over $40,000,000 damage. Because damaging earthquakes are shallow, the remainder of this paper will be restricted primarily to discussion of shallow-focus earthquakes.

It cannot yet be claimed that there is only one cause of all earthquakes. A minor cause of earthquakes is volcanic activity. Some deeper earthquakes may perhaps be related to sudden changes in rock properties due to motion deep within the Earth's mantle. However, most destructive, shallow-focus earthquakes appear to

be associated with a sudden rupturing (faulting) of the Earth's crust. (The crust is a rock layer of varying thickness, ranging from 30 miles under continents to 3 miles under oceans, which is found world-wide and is composed of mainly basaltic and granitic rocks.) The resulting earthquakes are caused by the sudden release of accumulative strain energy. The rupture, or break, is called a fault and is generally accompanied by displacement of blocks either vertically or horizontally or both, on opposite sides of the fracture.

This mechanical explanation of the creation of strong ground shaking, or an earthquake, only became widely accepted after the 1906 California earthquake. It is based on the "elastic rebound theory" of Professor H. F. Reid. Before Reid's time a common explanation was in terms of explosion-like phenomena at depth, often associated with the movement of hot magma (molten rock). In the 1906 earthquake, large-scale and continuous fault rupture was evident in the field. Of great importance, geodetic surveys of the region existed before and after the earthquake. The U. S. Coast and Geodetic Survey had made triangulation measurements across the San Francisco Bay region in 1851-65, 1874-92, and 1906-07. Reid interpreted these surveys as showing between the first and third surveys (a) little change in elevation, (b) significant horizontal right-lateral displacements of the crust parallel to the San Andreas fault, and (c) relative displacement of distant points on opposite sides of the fault of about 11 feet.

Reid stated, "It is impossible for rock to rupture without first being subjected to elastic strains greater than it can endure. We conclude that the crust in many parts of the Earth is being *slowly* displaced and the difference between displacements in neighboring regions sets up elastic strains. which may become larger than the rock can endure. A rupture then takes place and the then strained rock rebounds under its own elastic stresses, until the strain is largely or wholly relieved. In the majority of cases, the elastic rebounds on opposite sides of the fault are in opposite directions."

The seismic waves which are generated when the fault ruptures arise from the movement of the rocks in the vicinity of the fault.

At any point on the Earth's surface near to the fault, the wave motion will be complex. The *duration* of shaking at the point will depend roughly on the amount of displacement and largest linear extent of fault rupture. The variation of *intensity* of shaking with time will depend on the smoothness or otherwise, of the rupture and also on the position of the observer or building on the surface relative to the fault break;

if the fault ruptures toward the point the intensity may grow and then decline in some uneven way as the rupture moves away from the point. The ground motion will contain waves of many periods (or wave lengths). The higher frequency waves will be damped out by the rocks more quickly than the longer-period as the distance increases from the rupturing fault. In the epicentral area, the energy present in waves shorter than one second period may be quite high; at considerable distance from the epicenter, seismographs may detect mainly only waves with period of over 5 seconds. The energy in such long waves is an indication of the extent of the source, but, of course, does not lead to response by either humans or most structures.

SIZE OF EARTHQUAKES

Two measures of earthquake size have been found to be useful, *intensity* and *magnitude*. Unfortunately, these terms are often confused and sometimes even used synonymously. Magnitude attaches a single number to an earthquake which is independent of the distance from the earthquake center and independent of geological and soil conditions. For a measure of the *variation of ground motion* from point to point, an intensity scale is used. The intensity value is assigned by an experienced observer using a descriptive scale. Both measurements are too simple to describe the full complexity of an earthquake and should be used judiciously. Numerical relations between the two measures have been considered but, as the seismological literature shows, these must be taken only to establish an order of magnitude.

In discussions of earthquake hazard, the term *seismic risk* has been introduced. In its correct usage, *seismic risk* is the likelihood of damage from an earthquake. Quantitative studies of seismic risk are few and, like the other two measures of earthquake size, the word risk is often used loosely in this context.

Intensity Scales

Intensity is a rating of the severity of the ground motion at a specific location. The scale of measurement is based upon the sensations of persons, the behavior of natural objects, and upon physical damage to natural and man-made objects. Intensity scales came into being long before magnitude scales because intensity does not require instrumental observation. Over the years, different intensity scales have been devised. The scale must reflect the type of structure which is common to a particular region. The most widely accepted intensity scale in the United States is the Modified Mercalli Intensity Scale. This scale is given on the following page. It goes from I to XII on a twelve-point scale, usually denoted by Roman numerals.

A-6

MODIFIED – MERCALLI INTENSITY SCALE OF 1931

I **Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.**
Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.

II **Felt indoors by a few people, especially on upper floors of multi-story buildings, and by sensitive or nervous persons.**
As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.

III **Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.**
Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.

IV **Felt indoors by many, outdoors by few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Vibration like that due to passing of heavy, or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.**
Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeable.

V **Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.**
Buildings tremble throughout. Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerable. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake slightly.

VI **Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.**
Persons move unsteadily Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewhat. Many dishes and glasses, and a few windows, break. Knick-knacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.

VII **Frightens everyone. General alarm, and everyone runs outdoors.**
People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.

VIII **General fright, and alarm approaches panic.**
Persons driving cars are disturbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupts in small amounts. Flow of springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperatures of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet grounds and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.

IX **Panic is general.**
Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings - - some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometiines break.

X **Panic is general.**
Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations, are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks and broad wavy folds open in cement pavements and asphalt road surfaces.

XI **Panic is general.**
Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers, great to dams, dikes and embankments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly and some thrust endwise. Pipe lines buried in earth are put completely out of service.

XII **Panic is general.**
Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

Intensity ratings are bound to be subjective, as reported intensities may take on several meanings, depending on who reports them and the type of construction in an area. The reported intensity may be the maximum intensity at the built-up area nearest the epicenter, or it may be what the intensity should have been, at the epicenter based on observations at a center of population some distance away. Many circumstances arise making it difficult to assign intensities. The lack of precision in the intensity index should be recognized. Basically, intensity refers to the measure of earthquake effects of all types at a specified place. It is not based on the true measurement, but is a rating assigned by an experienced observer using a descriptive scale, with grades indicated by Roman numerals.

Because intensity is defined by the observed effects on the Earth's surface, such as landslides or underground pipes broken, the intensity of an earthquake on a mid-oceanic ridge might be taken as zero. On the other hand, a smaller shock centered near weak man-made structures on poor ground might yield a high intensity. For a given earthquake, intensity differs between localities depending upon the distance from the source, the duration of shaking, the geologic foundation and the quality of design and construction.

The subjective nature of intensity ratings makes it important that the observer report in detail the evidence upon which the rating was estimated. Engineers and others can then draw their own conclusions at a later time. In the United States, ratings are routinely gathered by the U. S. Coast and Geodetic Survey and the data are reported in "United States Earthquakes" which began in 1928.

In order to remove some of the subjectivity in assigning intensity, a dense network of strong-motion seismoscopes and seismographs would give quantitatively the distribution of ground motion. Only in the Los Angeles area is this now partly feasible. There are more than 130 strong motion seismographs and 75 seismoscopes located in the Los Angeles area. In the entire San Francisco Bay Area, there are only 34 strong motion seismographs and 48 seismoscopes.

Magnitude Scales

Magnitude is based on ground motion as recorded by distant seismographs. The most commonly used method of calculating magnitude in the United States for large earthquakes is that of C. F. Richter. (Other magnitude scales are, however, widely used by seismologists, both in the United States and in other countries, sometimes leading to what appears to be conflicting

magnitudes.) In order to use this scale, suppose that there is a particular kind of seismograph (called a Wood-Anderson instrument) at a distance of 60 miles from the epicenter. The instrument will produce a seismogram. A ruler with a centimeter scale is taken and the half-width ("amplitude") of the largest wave is measured and converted to microns (10^4 microns = 1 cm.). The logarithm (to base 10) of this number is the *Richter magnitude of the earthquake.* For example, if the maximum amplitude measured is 1 cm., the Richter magnitude is 4.0. Numerical tables provide the necessary adjustment when the seismograph is not at 60 miles epicentral distance or when other types of seismographs are used.

From the definition, the magnitude scale (unlike the intensity scale) has no greatest and smallest limit. Currently, more sensitive seismographs are available than when Richter defined magnitude in 1935; such instruments can record tiny earthquakes with minus or negative magnitudes, say -1.0. Large magnitudes have been recorded from the greatest earthquakes of the century. The 1964 Alaskan earthquake had a magnitude of about 8.6. Some of the early seismographs in Europe recorded the 1906 California earthquake and gave its magnitude to be near 8-1/4.

There is reason to believe that the largest earthquake which is mechanically possible under present geological conditions would have a magnitude less than about 9.0. The largest earthquakes recorded since the scale was devised are the Sauriku earthquake in Japan on March 2, 1933 with an estimated magnitude of about 8.9, and the earthquake centered off the west coast of South America, near Colombia in 1906, with perhaps a magnitude of 8.9.

Because the earthquake energy comes from elastic strain energy stored in the rocks, the total seismic energy released will be proportional in some way to the area of fault which ruptures. For great shallow-focus earthquakes, the depth of dislocation (say less than 30 miles) is small compared with the observed rupture length (of the order of hundreds of miles). Since the finite strength of crustal rocks limits the strain energy which they can store, the total energy release would thus appear to be bounded by the length of fault available to rupture. The geography of seismically active regions ruptures ever observed or estimated was 270 miles (California, 1906) and perhaps over 500 miles for the 1960 Chilean and 1964 Alaskan earthquakes.

While magnitude is a simple measure for ordering of earthquakes roughly according to size or total energy released, there is evidence that magnitude alone is often given too much weight in

urban planning and engineering design. This misuse comes from a failure to take into account the way that the partition of wave energy into various frequencies changes with the earthquake size and the great variation in rock and soil properties from place to place.

As an example, in Anchorage, after the 1964 earthquake, it has been pointed out that vibrational damage alone mainly affected only the tall high-rise buildings that respond to the longer frequency waves. An even more striking example is the Caracas, Venezuela earthquake, of 1967, where more than 200 lives were lost because of the collapse of five high-rise apartment buildings that were designed to be earthquake resistant. The Caracas earthquake was only a moderate-magnitude shock (Richter magnitude 6.5) and located approximately 30 miles from Caracas.

Consider, for example, structures which respond mainly to vibrations with periods of about 1/2 to 3/4 of a second; they will be most affected by that part of the earthquake which has similar periods. Due to relative attenuation in the rocks, however, the proportion of energy in waves with such periods falls with increased length of path so that waves coming from distant parts of the rupture will be mainly rich in longer periods. In simple terms, damage to small structures in a city from a large-magnitude earthquake nearby (long fault rupture) might be expected in general to be mainly a result of waves generated by the closest segment of the rupturing fault. Much the same wave energy might in the high frequency waves arise locally if *only* this local section of the fault ruptured (i.e., a smaller-magnitude earthquake occurred).

A number of empirical formulae linking magnitude and energy release have been worked out. For practical purposes, and particularly for the shallow earthquakes in California, the formula $\log_{10} E = 11.4 + 1.5\ M$ is recommended, where E is the energy in ergs, and M is the Richter magnitude.

Because of the factor 1.5, the increase of a unit in magnitude indicates an increase in energy of 32 times so that there is an enormous range of energy between the smallest and largest size earthquake. An attempt to indicate the great spread is shown in Figure A-2 where the energy in an earthquake is plotted as a multiple of that in the 1933 Long Beach earthquake.

Seismic Risk Scales

Risk may be thought of in context with its everyday meaning which is similar to hazard. Unlike hazard, however, risk has the connotation of probability or chance of loss (e.g., as used in the insurance industry). This meaning is valuable for

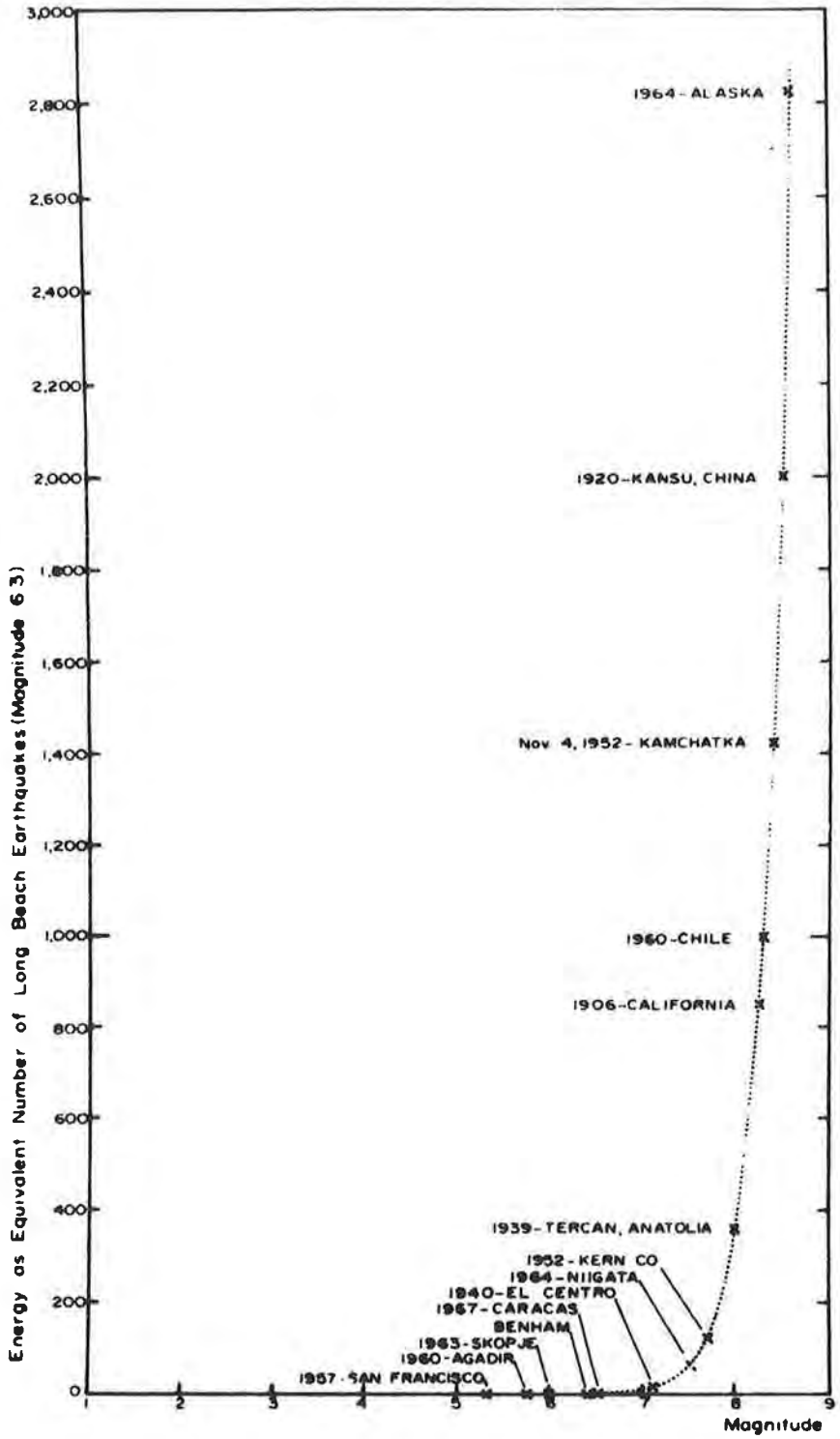


FIGURE A-2. Magnitude of an earthquake plotted against earthquake energy. In order to compress the energy scale, the energy values are equivalent numbers of 1933 Long Beach earthquakes.

setting a degree of likelihood of future earthquake damage and should be most carefully preserved.

Seismic (or Earthquake) Risk (SR) may be defined as the likelihood of damage or injury from an earthquake within a given time interval (design period). SR is normally given as a statement of probability. Like magnitude, there are different seismic risk scales. For example, statistical work on risk has been done in Mexico by Esteva and Rosenblueth and in Chile by C. Lomnitz and his co-workers. In a study for Santiago, Chile by F. Guzman, it was estimated that, in any 10-year period, the probability that the design acceleration of 10 percent of gravity will be reached or exceeded is about 60 percent.

A related measure of earthquake susceptibility is *Relative Seismic Risk* (RSR). The RSR scale replaces the probabilities of the SR scale by relative weighting factors. The scale usually ranges from 0 (no probability of damage) through 1, 2, 3, etc., with the highest number designating the region where risk is greatest. RSR weights or "seismic zone numbers" have been much used to modify requirements for lateral earthquake forces on structures as established by the California Earthquake Building Code. Relative seismic risk does not, however, show the statistical nature of risk as a function of time.

EARTHQUAKE ASSOCIATED DAMAGE

It is a commonly held misconception that distance from the surface trace of an active fault is the best assurance against earthquake damage. Experience has shown that the intensity of an earthquake is not necessarily highest at the surface trace of the earthquake-generating fault. If the structure is not astride an active fault, it matters little whether it is alongside the fault trace or several miles away, because energy reaching the surface will be almost the same at the two points, everything else being equal.

Earthquake damage depends on many variables: earthquake magnitude, epicentral location, depth of focus, duration of shaking, intensity of shaking, near-surface soil and geologic conditions, structural type, and design. Damage related to foundation conditions depends upon material density, shear strength, thickness, and water level. Thus, proximity to an active fault should not be given undue weight when deciding where to build; more consideration should be given to ground conditions and structural design.

Earthquake associated damage is usually manifest in four separate forms: (1) fault displacement; (2) strong ground motion (shaking); (3) ground failure; and (4) tsunamis (seismic sea waves).

Faulting

Faulting, as the movement or fracturing along faults is called, may have horizontal and vertical components of displacement and may vary from a fraction of an inch to many feet. In the California earthquake of April 18, 1906, horizontal offsets along the San Andreas fault averaged from 8 to 15 feet and occurred just north of San Juan Batista to north of Point Arena, a distance of more than 200 miles.

Fracturing and shearing associated with faulting is often observed in the field to be of a multiple and en echelon character, with several planes of displacement being formed through geologic time (millions of years); thus the term fault zone is a more realistic designation. The exact location and characteristics of a fault zone are of vital concern in estimating the hazard from faulting. Once a fault is formed, it constitutes a plane of weakness that localizes further adjustments. Active faults usually are associated with one or more of the following: an historic record of faulting, the occurrence of earthquakes along their courses, evidence of geologically recent movement (the last few thousand years), and slow fault slippage. A fault should be considered active if it has displaced recent alluvium or other recently formed deposits, whose surface effects have not been modified to an appreciable extent by erosion, which has earthquakes located in the near vicinity, and whose recurrence of movement is expected.

Some fault zones, such as the San Andreas, are more than a mile wide in places, containing many "fault traces" within the broad zone. One might ask, "What is the relative risk of developing or locating structures within such wide active fault zones?" Assigned risk (SR or RSR) need not always be extreme. It depends upon factors such as type of development, intended land use, type of structure, and site location with respect to the *active* fault traces. The broad fault zones have been formed over long periods of geologic time and in some future geologic time (millions of years) not only may the present fault traces be reactivated, but new traces may be formed. However, if we consider this problem from the standpoint of "engineering design time," (of the order of 100 years say) the probability of fault movement is much higher along the most recent fault traces that lie within the broad fault zone. In such risk assessments perhaps weak soil conditions which may arise from crushed rock or gouge in a fault zone would turn out to be more crucial factors than concern over the exact positions of future faulting.

It is often believed that assurance against earthquake damage is directly proportional to the distance from the surface trace of a known active fault or fault zone. There is much evidence

that the intensity of an earthquake is not necessarily highest at the surface trace of the earthquake-generating fault. If the structure is not astride an active fault trace, so that displacement may shear it in two, it may not be decisive as a damage factor whether it is alongside the fault trace or several miles away; wave energy reaching the two sites may be comparable. Damage resulting from faulting occurs only where works of man are located astride the fault traces that move. Figure A-3 shows damage to a fence that was across the 1906 fault trace. Note the undamaged buildings of wood-frame, low-story construction located near the fault. They are also located on stable ground. By contrast, buildings located 10 to 20 miles from the fault, such as in Santa Rosa and San Jose, on relatively less stable ground were almost completely destroyed in the 1906 shock.

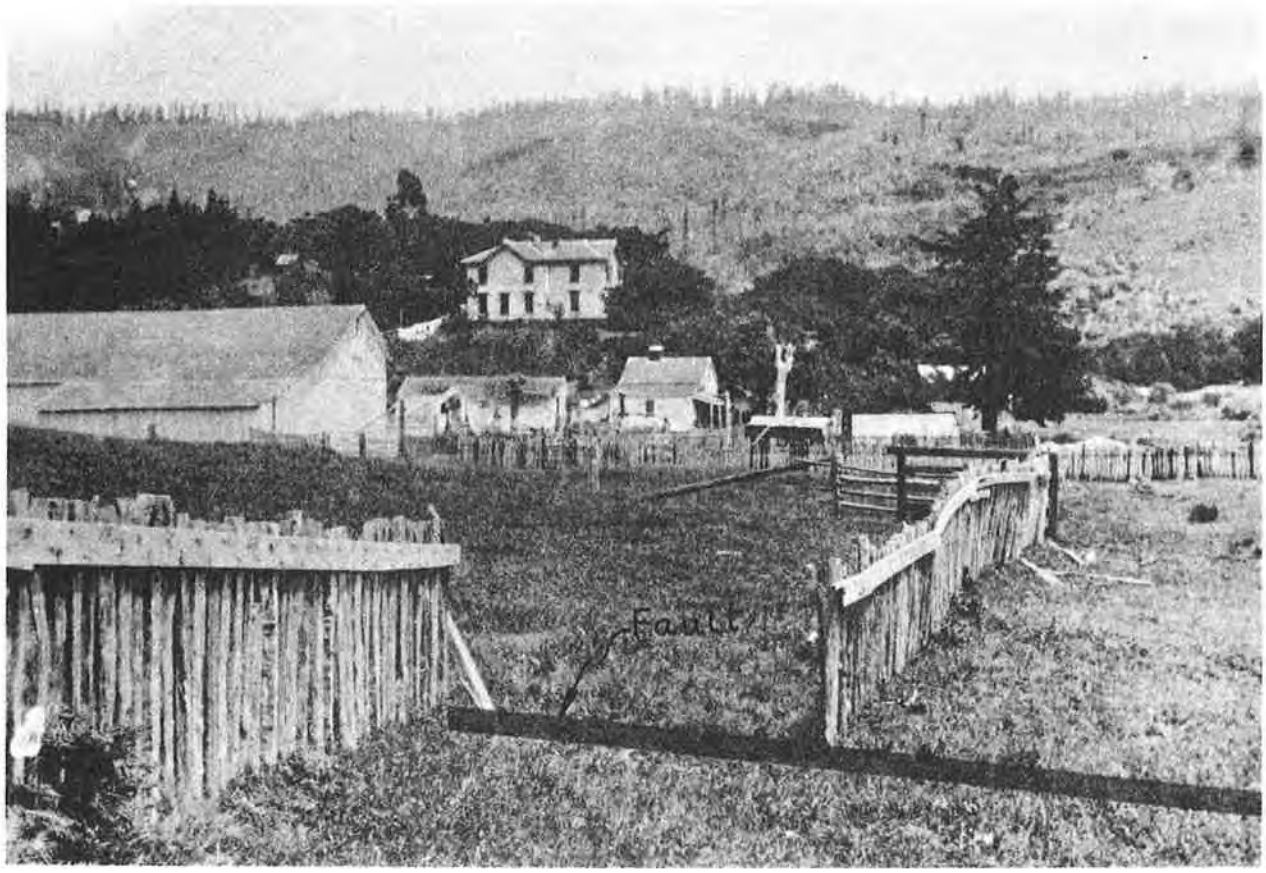


FIGURE A-3. Fence separated by displacement along the San Andreas Fault, April 18, 1906.

Avoidance of damage from fault dislocation can be achieved by recognizing the most active fault traces and either locating structures elsewhere, or allowing for fault movement in the design. This is a significant hazard only in a few localities.

Strong Ground Motion (Shaking)

Damage from strong ground motion (shaking) is caused by the transmission of earthquake vibrations from the ground into the structure. Figure A-4 shows damage to the Mijagual apartment building in Caracas, Venezuela from the 1967 earthquake. The main variable factors that determine the extent of vibrational damage are: type of ground, earthquake-resistant design, quality of materials and construction, and intensity and duration of shaking.

FIGURE A-4. Mijagual high-rise apartment building in Caracas, Venezuela, showing total pancake collapse.

Different kinds of ground respond differently to seismic loading. The relation between soil and basement rock conditions and earthquake shaking is not clearly known. Estimates can be calculated if soil and basement rock properties are known but should be used with caution for risk estimation until more testing under actual earthquake conditions is done. The ground motion associated with a great earthquake (similar to the 1906 California shock) has never been recorded instrumentally.

Many urban areas are presently located along and near active faults. For example, along the San Andreas fault, throughout its length from Northern to Southern California, along the Calaveras fault near Pleasanton, along the Hayward fault in the East Bay Cities, along the San Jacinto and Inglewood faults in Los Angeles and southern California, and the Wasatch fault near Salt Lake City, Utah. Continuing urban growth is bringing about a constant increase in the use of land near active faults that will most likely be associated with substantial earthquakes. Outside the city areas, industrial and utilities development is frequently considered for sites close to active faults. A case which gave rise to strong public controversy is the Bodega Head site north of San Francisco considered a few years ago for a nuclear power reactor.

In these circumstances the following question is becoming increasingly frequent; "In what ways, if any, does the strong ground motion differ near the fault from the ground motion some distance away?" No strong motion records were obtained of the large 1960 Chilean earthquake nor in Alaska from the 1964 shock. A widely used strong-motion record in engineering design is the El Centro record. It, however, was obtained about 6 miles from the Imperial Valley fault along which displacements were observed in the 1940 earthquake, magnitude 6.9. In 1966, an array of strong-motion instruments was operational across the San Andreas fault near Cholame. These instruments recorded the earth movements at the time of the June 27, 1966 Parkfield earthquakes. A record of ground acceleration was obtained within the fault zone about 200 feet from a fault trace that contained a slippage crack that appeared across Highway 46 where it intersects the San Andreas fault zone. These records are the closest to an earthquake source (active fault) yet obtained. (The records showed that the vertical and horizontal motions of the ground differed considerably in their frequency content and structure.) There was a large ground motion (which amounted to a displacement of 10 inches) perpendicular to the fault trace. The maximum horizontal ground acceleration was one-half the acceleration of gravity (0.5g), i.e., about 16 feet/sec^2. The duration of the strong ground motion was extremely short, lasting only about 1 second.

Although the record gives valuable information it is unclear whether the effects mentioned above could be scaled upwards for a large earthquake. The Parkfield main shock had a magnitude of 5.6 and the length of fault rupture observed was somewhat less than 20 miles. Very little damage was reported along the fault zone even though the short duration peak acceleration was surprisingly quite high. It is not clear whether a much larger magnitude earthquake might produce significantly greater accelerations near the fault; a longer interval of ground shaking (duration) is, however, quite likely.

FIGURE A-5. Earthquake damage resulting from ground failure. Turnagain Heights landslide, Anchorage, Alaska, March 27, 1964.

Because we lack direct observations, forecasts of ground motion must be largely based on extrapolation from experiments in the laboratory, from visual observations of past earthquakes, and upon suggestions from theoretical models. Certain likely properties of the ground motion near a fault can be stated for risk estimation, subject to the necessary caution implied by the above statement of our lack of current observational information.

Damage from Ground Failure

Damage from ground failure may occur in several different forms; landsliding, liquefaction, and settlement. Figures A-5 and A-6 illustrate damage from landsliding and liquefaction.

FIGURE A-6. Earthquake damage resulting from ground failure: Liquefaction. Niigata, Japan, 1964.

If the proper geological conditions exist on the ocean floor, subaqueous landslides or turbidity currents may be generated of sufficient force to affect offshore and onshore structures. In 1929, an earthquake in the North Atlantic triggered a high-velocity, high-density turbidity current that is believed to have led to the shearing of 11 Trans-Atlantic communication cables. The sea floor over which this flow occurred had no more than a 2% to 5% slope. Numerous subaqueous landslides occurred during the 1964 Alaska earthquake causing extensive damage to nearby areas especially from large water waves that were generated by the landsliding. Saturated granular layers located at shallow depth below the surface may be susceptible to liquefaction during an earthquake. This phenomenon has frequently been observed in the past, notably in Niigata, Japan, in 1964 and Chile in 1960 as shown in the photograph, Figure A-6. In general, the greater the depth and the relative density of a submerged sand layer, the less is the danger of liquefaction. Shallow loose saturated sands appear to be most liquefiable, deep dense sands least liquefiable.

TSUNAMIS (SEISMIC SEA WAVES)

Tsunami (Seismic Sea Waves) -- Water waves may be generated in the ocean by large submarine earthquakes. The mechanism is probably rapid vertical displacement of part of the ocean floor through faulting or, sometimes, by submarine landslides. Such waves are called *tsunamis* or *seismic sea waves*.

In the open ocean, tsunamis are characterized by long wave length (on order of hundreds of miles), long periods of oscillation (about an hour), high velocities (more than 600 miles per hour), and low wave heights (no more than a few feet). Shoaling begins as the ocean becomes shallower than one-half the wave length of the acting wave. Tsunamis, therefore, begin to react as they approach the shore by decreasing velocity and increasing wave height. Their approach is typically indicated by water withdrawal followed by a series of wave surges. Some surges have attained heights of 75-100 feet. Recorded surge heights of 50 feet are not uncommon along the Hawaiian shores. An earthquake in the Aleutian trench on April 1, 1946 generated a tsunami which impinged on the California coast and forced water to 11 feet at Half Moon Bay and 12 feet at Santa Cruz. The 1964 Alaskan earthquake generated a tsunami which resulted in damage in a number of places in the Pacific. The tsunami was disastrous at Crescent City, California, where it reached a height of 20.7 feet above mean sea level killing 11, injuring 35, and causing about $8,500,000 in property damage.

Mendocino County reported damage to fishing boats in Noyo Harbor, with 10 sunk. In Marin County, $1,000,000 damage occurred to small boats and berthing facilities. There was

damage to docking facilities in Los Angeles County and Long Beach Harbor. California had a longer time to prepare for the onslaught of the sea wave than other Pacific states. However, there was lack of sensible response among the public. Newspapers estimate 10,000 curious people waited on the San Francisco beaches to watch the tsunami arrive.

EARTHQUAKE RISK ESTIMATION AND DAMAGE CONTROL

There is no way known to predict exactly where, or when, the next sudden fault displacement will occur, or how strong the resulting earthquake will be. However, provided sufficient geological and seismological information is available, the prediction of the general level of earthquake activity for a given region may be attempted. This is the starting point for the estimation of the seismic risk (SR) or relative seismic risk (RSR) throughout the region. In seismic regions such as the San Francisco Bay Area, minor perceptible earthquakes of Richter magnitude less than 5.0 may be expected yearly. A large percentage of the earthquakes will fall within this harmless level, and will seldom result in substantial ground breakage along an active fault, or in damage to adequately designed structures. Every so often an earthquake of greater magnitude (from 5.0 to 6.0) may occur, causing some damage in localized areas, especially to structures not designed to resist shaking (or to structures located on poor ground), but will not adversely affect properly designed structures. Earthquakes having a Richter magnitude above 6.5 usually occur many years apart, and are usually associated with significant surface ground ruptures along the fault, and damage to structures astride the displaced fault trace. It is largely a task for the future to prepare detailed SR and RSR maps of California, based on seismicity as well as geologic and soil conditions.

Although exact time and location of the next earthquake in a seismic region cannot now be predicted from past experience and recently acquired knowledge, the general *effects* can be reasonably predicted provided there is knowledge and understanding of the main variable factors that influence earthquake effects and damage. These factors include: (1) size (Richter magnitude), and depth of the earthquake, (2) epicentral distance or distance to the ruptured fault, (3) duration and frequency content of strong ground motion, and (4) underlying geological and soil conditions. A further factor is the extent to which precautions have been taken by industry, governmental agencies, school boards, planning commissions, and private individuals to reduce the damaging effects through proper planning, design, and construction. The last may be the most important because it is the one factor man can hope to control.

In conclusion, it is important to recognize the interdisciplinary nature of solving problems associated with earthquake hazards. The solution to many of these problems will be dependent upon the ability of the seismologist, geophysicist, geologist, and earthquake engineer to evaluate and delineate the basic causes and effects of earthquakes and communicate this information in practical terms. The result of such work can only be translated into effective action by the cooperation of planners, engineers, public officials and contractors, to reduce life loss and property damage in the next major earthquake. Broad public and governmental support must also exist.

APPENDIX B

RECENT CALIFORNIA LEGISLATION PERTAINING TO ACTIVE FAULTS AND GEOLOGIC HAZARDS

Since publication of our first report entitled, "Wasatch Fault, Northern Portion, A Guide to Land-Use Planning," new legislation pertaining to earthquake hazards has been proposed and is being considered by the California Legislature. This appendix contains examples of this new legislation. The following examples have been selected in order to show how California is facing the problems of development in seismic areas. Utah should select appropriate legislative acts and modify where necessary and apply them to problems which may be unique to Utah.

SENATE BILL 1041

Establishment of California Seismic Safety Commission

Establishes the California Seismic Safety Commission for the purpose of studying seismic hazards and developing plans to avert insofar as is possible the ensuing disaster which may follow an earthquake. Appropriates $100,000 from the General Fund for creation and operation.

(a) The urban areas of the State of California contain serious types of earthquake-related hazards and hazard-increasing circumstances which are potentially extremely dangerous to the health and welfare of its citizens.

(1) They are traversed by major active faults.

(2) They have filled land and water-saturated subsoils.

(3) They contain hillsides and slopes that can be built upon, but that are also susceptible to slides.

(4) They possess many water-storage dams and reservoirs.

(5) They continue to experience rapid urban growth.

(6) They contain both old and new structures of many types of design and construction, including high-rise buildings.

(b) California has the human resources needed to make important new contributions to the solution of the earthquake hazard problem.

8860.2. The Legislature further finds and declares that in order to protect the public interest:

(a) A statewide study of earthquake-related hazards is necessary.

(b) A statewide study can best be accomplished by the California Seismic Safety Commission created by this chapter comprised of representatives of the state government, the cities and counties concerned with the problem of earthquake hazards, the general public, and the chairmen of the technical advisory groups created to assist the commission with its duties.

(c) The study should begin with a detailed analysis of existing seismic hazards, and the effect of such hazards on future decisions on planning and urban development, on housing, and industrial location, on construction design, on specifications for dams and reservoirs, on fault-zone planning and zoning, on regulation of building on filled land or hillsides susceptible to slides, and on the need for removal or modification of parapets.

(d) The commission shall also consider the problem of planning for appropriate and effective postearthquake responses to disaster, including

effective responses to the problems of immediate rescue and rehabilitation, and reconstruction and relocation over a longer period of time.

(e) The commission shall be assisted by the advisory groups set forth in Article 4 (commencing with Section 8863) of this chapter. These groups shall provide such technical and factual information as the commission determines will be necessary in order that it may effectively carry out its duties.

8860.4. The Legislature further finds and declares that the California Seismic Safety Commission, after conducting studies and formulating policies under Article 1 of this chapter, shall recommend to the Legislature the appropriate means of carrying out the policies and plans it develops.

Article 2. Creation and Membership

8861. There is in the state government a California Seismic Safety Commission. The commission shall include:

(a) One representative from each of the counties, classes 1 through 6. as determined by the 1960 federal census, appointed by the board of supervisors of each county.

(b) Four representatives of cities having a population exceeding 740,000 as determined by the 1960 federal census appointed by the League of California Cities.

(c) Five citizens of California appointed by the Governor and subject to Senate confirmation.

(d) One representative of the San Francisco Bay Conservation and Development Commission appointed by its director.

(e) The State Planning Officer.

(f) The chairmen of the advisory groups set forth in Article 4 (commencing with Section 8863).

(g) The chairmen of advisory groups created by the commission subsequent to the effective date of this act.

(h) One Member of the Senate, appointed by the Senate Rules Committee, and one Member of the Assembly appointed by the Speaker of the Assembly, who shall serve on the commission to the extent that such service is not incompatible

with their duties as Members of the Legislature. For the purposes of this chapter, such Members of the Legislature shall constitute a joint interim investigating committee on the subject of this chapter, and as such shall have the powers and duties imposed upon such committee by the Joint Rules of the Senate and Assembly.

8861.2. The members of the commission shall serve at the pleasure of their respective appointing powers. The members shall serve without compensation, but each of the members shall be reimbursed for his necessary expenses incurred in the performance of his duties. A member may authorize no more than one proxy for attendance at meetings or for voting, which proxy may be designated, in writing, at the time the member is appointed to the commission. The name of the proxy shall be filed with the commission.

8861.4. The commission shall elect, from among public representatives on the commission a chairman and a vice chairman.

8861.6. The time and place of the first meeting of the commission shall be prescribed by the Governor, but in no event, shall it be scheduled for a date later than 10 days after the effective date of this chapter. The Governor shall appoint an interim chairman to serve until the commission elects a chairman.

8861.8. The headquarters of the commission shall be in the City and County of San Francisco.

Article 3. Powers and Duties of the Commission

8862. The commission shall make a detailed study of all the matters referred to in Article 1, and shall, upon the basis of such study, prepare comprehensive plans to minimize the effect of seismic hazards on the people and resources of the state.

(a) The commission shall submit a plan to the Legislature suggesting methods for revising the recommendations contained in the study as greater knowledge is obtained about earthquakes in general, the specific earthquake hazards in the state, the responses to earthquake shocks of various kinds of soils and structures, and other relevant matters.

(b) The commission shall also submit a plan recommending those measures that might be taken to reduce the likelihood of personal injury or death,

or structural failure, in future earthquakes.

(c) The commission shall submit a plan for postearthquake responses to a disaster.

In making its study, the commission shall cooperate to the fullest extent possible with existing regional agencies; and in preparing its comprehensive plan, the commission shall, to the fullest extent possible, coordinate its planning with local agencies. In order to avoid duplication of work, the commission shall make maximum use of data and information available from the planning programs of the State Office of Planning, Bay Area Transportation Study Commission, the Association of Bay Area Governments, the cities and counties, and other public and private planning agencies.

8862.2. The commission may:

(a) Accept grants, contributions, and appropriations from any public agency, private foundation, or individual.

(b) Appoint committees from its membership and appoint advisory groups from other interested public and private groups. The commission shall determine the composition and the membership of each additional advisory group.

(c) Contract for or employ any professional services required by the commission or for the performance of work and services which in its opinion cannot satisfactorily be performed by its officers and employees, its advisory groups, or by other federal, state, or local governmental agencies.

(d) Do any and all other things necessary to carry out the purposes of this chapter.

8862.4. The commission shall, in addition to any funds which the Legislature may appropriate for planning activities of the commission, take whatever steps are necessary to attempt to obtain money available for such planning activities from any federal, state, or local sources.

8862.6. The commission shall appoint an executive director who shall have charge of the conduct of the study and plan formulation, subject to the direction and policies of the commission. The executive director shall, subject to approval of the commission, appoint such employees as may be necessary in order to carry out the functions of the commission.

8862.8. Within a reasonable time, but not tc exceed one year from the date of the first meeting of the commission, the chairman of the commission,

in collaboration with and with the concurrence of the commission, shall appoint a citizens' advisory committee to assist and advise the commission in carrying out its functions. The advisory committee shall consist of not more than 20 members.

Article 4. Advisory Groups to the California Seismic Safety Commission

8863. The commission shall be advised by an Advisory Group on Engineering Considerations and Earthquake Sciences.

This group shall review available scientific and engineering knowledge relative to the reduction of the risks of damage due to earthquake and related geologic hazards. It shall make recommendations to the commission based upon its findings. Its judgment in the fields of engineering and earthquake sciences shall guide all other advisory groups. It shall review the progress reports of all other advisory groups and may recommend such changes, elaborations, or new directions as may appear desirable. It shall provide, insofar as feasible, technical information and opinions on submitted questions to other advisory groups.

8863.1. The composition of the Advisory Group on Engineering Considerations and Earthquake Sciences shall include:

(a) One representative of the Division of Mines and Geology appointed by the Secretary of the Resources Agency.

(b) One representative of the Division of Safety of Dams appointed by the Secretary of the Resources Agency.

(c) One representative of the Office of Architecture and Construction appointed by the State Architect.

(d) Seven persons with experience and acknowledged reputations in the relevant professional fields shall be appointed by the commission as follows:

(1) One representative after consultation with the officers of the California Sections of the American Society of Civil Engineers.

(2) One representative after consultation with the officers of the Structural Engineers Association of California.

(3) One representative after consultation with the officers of the California Chapter, Association of Engineering Geologists.

(4) One representative after consultation with the officers of the California Council of the American Institute of Architects.

(5) Three representatives after consultation with the officers of the Earthquake Engineering Research Institute.

(e) Two persons representing appropriate academic disciplines appointed by the commission after consultation with the Chancellors of the University of California, Berkeley, University of California, Los Angeles, and University of Southern California, and the President of Stanford University.

(f) Two members appointed from the public at large at the discretion of the commission.

8864. The commission shall be advised by an Advisory Group on Disaster Preparedness.

This group shall be responsible for reviewing and evaluating the adequacy of existing disaster plans insofar as they relate to the probable consequences of disastrous earthquakes. The group should give special emphasis to the development of plans to marshal human, physical, and economic resources necessary to minimize human and material losses flowing from earthquake disaster, and to facilitate restoration of the normal life of the region as expeditiously as possible. The group should recommend preearthquake measures that will help to minimize human and material losses flowing from earthquake disaster.

8864.1. The composition of the Advisory Group on Disaster Preparedness shall include:

(a) One representative of the U.S. Office of Emergency Preparedness appointed by the Director of the Office of Emergency Preparedness.

(b) One representative appointed by the Director of the Disaster Office of the Governor's Council.

(c) Seven persons appointed by the commission with knowledge in fields relevant to disaster preparedness, including not less than one physician, one representative of a public utility, one civil engineer, one architect, and one representative of the American Red Cross.

(d) Five representatives of local government, appointed by the commission. Two of these representatives shall be building inspectors of cities and each building inspector shall hold a valid California civil engineer's license.

(e) Three members appointed from the public at large or from private organizations at the discretion of the commission.

8865. The commission shall be advised by an Advisory Group on Postearthquake Recovery and Redevelopment.

This group shall be responsible for recommending a series of general contingency plans to guide the long-term work of recovery, reconstruction, relocation where desirable, and redevelopment. The plans shall include variable courses of action based upon the several parameters of earthquake location, duration, intensity and damage.

8865.1. The composition of the Advisory Group on Postearthquake Recovery and Redevelopment shall include:

(a) Four persons appointed by the commission from the fields of insurance, banking and finance, law, and urban renewal.

(b) Four persons with experience and acknowledged reputations in relevant professional fields appointed by the commission as follows:

(1) One representative after consultation with the officers of the California Chapter of the American Institute of Planners.

(2) One representative after consultation with the officers of the California Council of the American Institute of Architects.

(3) One representative after consultation with the officers of the California Sections of the American Society of Civil Engineers.

(c) Three representatives of local government after consultation with the League of California Cities and the County Supervisors' Association.

(d) One representative of the Department of Housing and Community Development appointed by the director.

(e) Two representatives of the public at large appointed at the discretion of the commission.

8866. The commission shall be advised by an Advisory Group on Land Use Planning.

This group shall determine the limitations that should be placed upon the use of land subject tc seismic hazard for appropriate inclusion in the land use plans of state, regional, and local governments.

8866.1. The composition of the Advisory Group on Land Use Planning shall include:

(a) Three representatives of local government, appointed by the commission after consultation with the League of California Cities and the

California Supervisors Association.

(b) Five persons with experience and acknowledged reputations in relevant professional fields appointed by the commission as follows:

(1) Two representatives after consultation with the officers of the California Chapter of the American Institute of Planners.

(2) One representative of the California Sections of the American Society of Civil Engineers.

(3) One representative of the California Council of the American Institute of Architects.

(4) One representative of the California Chapter of the Association of Engineering Geologists.

(c) One representative of the State Office of Planning appointed by the State Planning Officer.

(d) Two representatives of the academic community appointed by the commission after consultation with the Chancellors of the University of California, Berkeley, University of California, Los Angeles, and University of Southern California, and the President of Stanford University.

(e) Two representatives of the public at large appointed at the discretion of the commission.

8867. The commission shall be advised by an Advisory Group on Governmental Organization and Performance.

This group shall study local government organization so as to determine how the plans formulated by the other advisory groups to reduce the risk of loss due to earthquake disaster may best be carried into effect. It shall recommend modifications in existing government organization so that local government jurisdiction is sufficient to enable it to exercise the requisite authority to make the emergency measures effective. It shall recommend new governmental institutions should they appear essential.

8867.1. The composition of the Advisory Group on Governmental Organization and Performance shall include:

(a) Two representatives of local government appointed by the commission after consultation with the League of California Cities and the California Supervisors Association.

(b) Five persons appointed by the commission after consultation with the city councils of the Cities of Los Angeles, San Francisco, Oakland,

San Diego, and San Jose.

(c) Three persons appointed by the commission who have been active in California state or local governmental studies.

(d) Three representatives of the public appointed by the commission.

(e) Two representatives of the academic community appointed by the commission after consultation with the Chancellors of the University of California, Berkeley, University of California, Los Angeles, and University of Southern California, and the President of Stanford University.

(f) Two representatives from the public at large appointed at the discretion of the commission.

8868. Each advisory group shall elect its chairman and vice chairman from among its members. The chairman shall be a voting member of the commission.

8869. The commission shall make sure that the plans developed under this chapter to minimize the risk of loss following earthquake disaster are coordinated with similar plans developed by federal, state, regional, and local government, and the private sector.

Article 5. Final Report and Termination of Existence of the Commission

8870. The commission shall file a progress report with the Governor and the Legislature not later than the fifth legislative day of the 1972 Regular Session of the Legislature, and shall file a final report with the Governor and the Legislature not later than the fifth legislative day of the 1974 Regular Session of the Legislature. The final report shall contain all of the following:

(a) The results of the detailed study made by the commission.

(b) A plan for the continuous revision of the study as new information is obtained.

(c) A plan for immediate actions which will minimize earthquake hazard to life and the resources of the state.

(d) The comprehensive plan adopted by the commission for the appropriate and effective response to an earthquake disaster after it happens.

(e) Such other information and recommendations as the commission deems desirable and will further the public interest in seismic safety.

8871. The existence of the commission and the provisions of this chapter (commencing with Section 8860) shall remain in effect until the 90th day after the final adjournment of the 1974 Regular Session of the Legislature, and shall have no force or effect after that date.

SEC. 2. If any provision of this act or the application thereof to any person or circumstances is held invalid, such invalidity shall not effect other provisions or applications of the act which can be given effect without the invalid provision or application, and to this end the provisions of this act are severable.

SEC. 3. The sum of one hundred thousand-dollars ($100,000) is appropriated from the General Fund for the creation and operation of the California Seismic Safety Commission for the 1969-1970 fiscal year.

SENATE RESOLUTION - No. 128

Establishment of a Joint Committee on Seismic Safety

WHEREAS, The State of California has a positive interest in minimizing the disastrous effects of major earthquakes particularly in the heavily populated areas of the state such as the San Francisco Bay and the Los Angeles metropolitan areas; and

WHEREAS, An earthquake of the magnitude of the 1906 San Francisco catastrophe should it occur today could result in untold loss of life and inestimable property damage due to the rapid growth of urban areas in the past 60 years: and

WHEREAS, The Legislature finds that a considerable reduction in catastrophic damage due to earthquake could possibly be achieved if a detailed study is undertaken to determine the nature of California seismic and related hazards, the effect of seismic rupture upon existing metropolitan structures, utility services, transportation, communications, and the general welfare, and in what manner precautions can be taken to minimize the damage, loss of life, and disruption to the economy should a major earthquake occur; and

WHEREAS, The San Francisco Bay area is a most logical place for such

a study to begin since the area contains almost all the types of earthquake-related hazards and hazard-increasing circumstances to be found in the state: It is traversed by two major active faults; it has filled land and water-saturated subsoils; its topography includes inhabited hillsides and slopes susceptible to slides; it has many water storage dams and reservoirs; it is heavily populated with attendant urban problems; it has both old and new structures of widely varying design; and it is a nine-county area large enough to permit a thorough and comprehensive study, the findings of which will be of practical value throughout the state; now, therefore, be it

Resolved by the Senate of the State of California, the Assembly thereof concurring. As follows:

1. The Joint Committee on Seismic Safety is created and authorized to study with particularity the earthquake related problems confronting the San Francisco Bay area and so much other of the state as it should appear advisable; the committee is further directed to develop seismic safety plans and policies and recommend to the Legislature any needed legislation to minimize the catastrophic effects upon the people, property, and the operation of our economy should a major earthquake strike any portion of the State of California.

2. The Joint Committee on Seismic Safety shall consist of four members of the Senate appointed by the Committee on Rules which shall also appoint the chairman, plus four members of the Assembly appointed by the Speaker of the Assembly who shall also appoint the vice chairman.

3. There shall be an advisory commission to the joint committee. The advisory commission shall consist of:

(a) One representative from each of the nine bay area counties appointed by the board of supervisors of each county.

(b) Four representatives of bay area cities appointed by the Association of Bay Area Governments.

(c) Five representatives of the public appointed by the Governor and subject to Senate confirmation. These members shall be residents of the San Francisco Bay Area.

(d) One representative of the San Francisco Bay Conservation and Development Commission appointed by its director.

(e) The State Planning Officer.

(f) The chairmen of technical advisory groups created by the commission subsequent to the effective date of this act.

(g) The chairmen of technical advisory groups set forth below:

(1) Advisory Group on Engineering Considerations and Earthquake Sciences.

This group shall review available scientific and engineering knowledge relative to the reduction of the risks of damage due to earthquake and related geologic hazards. It shall make recommendations to the commission based upon its findings. Its judgment in the field of engineering and earthquake sciences shall guide all other advisory groups. It shall review the progress reports of all other advisory groups and may recommend such changes, elaborations, or new directions as may appear desirable. It shall provide, insofar as feasible, technical information and opinions on submitted questions to other advisory groups.

(2) Advisory Group on Disaster Preparedness

This group shall be responsible for reviewing and evaluating the adequacy of existing disaster plans insofar as they relate to the probable consequences of disastrous earthquakes. The group should give special emphasis to the development of plans to marshal human, physical, and economic resources necessary to minimize human and material losses flowing from earthquake disaster, and to facilitate restoration of the normal life of the region as expeditiously as possible. The group should recommend preearthquake measures that will help to minimize human and material losses flowing from earthquake disaster.

(3) Advisory Group on Postearthquake Recovery and Redevelopment

This group shall be responsible for recommending a series of general contingency plans to guide the long-term work of recovery, reconstruction, relocation where desirable, and redevelopment. The plans shall include variable courses of action based upon the several parameters of earthquake location, duration, intensity, and damage.

(4) Advisory Group on Land Use Planning

This group shall determine the limitations that should be placed upon the use of land subject to seismic hazard for appropriate inclusion in the land use plans of state, regional, and local governments.

(5) Advisory Group on Governmental Organization and Performance

This group shall study local government organization so as to

determine how the plans formulated by the other advisory groups to reduce the risk of loss due to earthquake disaster may best be carried into effect. It shall recommend modifications in existing government organization so that local government jurisdiction is sufficient to enable it to exercise the requisite authority to make the emergency measures effective. It shall recommend new governmental institutions should they appear essential.

4. The Joint Committee on Seismic Safety and its members shall have and exercise all of the rights, duties and powers conferred upon investigating committees and their members by the provisions of the Joint Rules of the Senate and the Assembly as they are adopted and amended from time to time, which provisions are incorporated herein and made applicable to this committee and its members.

5. The joint committee shall have the following additional powers:

(a) To meet at such times and places as it may deem proper.

(b) To employ such professional, secretarial and clerical staff, together with such special assistants and consultants as may be necessary.

(c) To contract with such other agencies, public or private, as it deems necessary, for the rendition of such services, facilities, studies, and reports to the joint committee as will best assist it to carry out its duties and responsibilities.

(d) To cooperate with and to secure the cooperation of county, city, city and county, regional, multicounty and other local agencies in investigating any matter within the scope of its duties and responsibilities.

(e) To cooperate with any federal, state or local agency, public and private, which is engaged in making studies of earthquake hazard.

(f) To accept funds from federal, state, and local agencies, and to receive contributions from private sources.

(g) To do any and all other things necessary or convenient to enable it fully and adequately to perform its duties and to exercise the powers expressly granted it.

6. The committee shall file a report with the Legislature not later than the fifth legislative day of the 1972 Regular Session of the

Legislature. The report shall contain:

(a) The results of the detailed study made by the committee.

(b) A plan for continuous revision of the study as new information is obtained.

(c) A plan to minimize the probable loss to life, property, and minimize the disruption of the local economy should an earthquake disaster occur.

(d) A plan for appropriate and effective response to the immediate problems arising after an earthquake disaster.

(e) Such other information and recommendations as the commission deems desirable.

7. The sum of ninety-nine thousand one hundred three dollars ($99,103) or so much thereof as may be necessary is hereby made available from the Contingent Funds of the Assembly and Senate for the expenses of the committee and its members and for any charges, expenses or claims it may incur under this resolution, to be paid from the said fund and disbursed, after certification by the chairman of the committee, upon warrants drawn by the State Controller upon the State Treasurer.

SENATE BILL 691

An Act to Amend Section 65302 of the Government Code, Relating to Planning

The people of the State of California do enact as follows:

SECTION 1. Section 65302 of the Government Code is amended to read:

65302. The general plan shall consist of a statement of development policies and shall include a diagram or diagrams and text setting forth objectives, principles, standards, and plan proposals. The plan shall include the following elements:

(a) A land use element which designates the proposed general distribution and general location and extent of the uses of the land for housing, business, industry, open space, including agriculture, natural resources, recreation, and enjoyment of scenic beauty, education, public buildings and grounds, solid and liquid waste disposal facilities, and

other categories of public and private uses of land. The land use element shall include a statement of the standards of population density and building intensity recommended for the various districts and other territory covered by the plan. The land use element shall also identify areas covered by the plan which are subject to flooding and shall be reviewed annually with respect to such areas.

(b) A circulation element consisting of the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities, all correlated with the land use element of the plan.

(c) A housing element consisting of standards and plans for the improvement of housing and for provision of adequate sites for housing. This element of the plan shall endeavor to make adequate provision for the housing needs of all economic segments of the community.

(d) A conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources. That portion of the conservation element including waters shall be developed in coordination with any countywide water agency and with all district and city agencies which have developed, served, controlled, or conserved water for any purpose for the county or city for which the plan is prepared. The conservation element may also cover:

(1) The reclamation of land and waters.

(2) Flood control.

(3) Prevention and control of the pollution of streams and other waters.

(4) Regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan.

(5) Prevention, control, and correction of the erosion of soils, beaches, and shores.

(6) Protection of watersheds.

(7) The location, quantity and quality of the rock, sand and gravel resources.

(e) An open-space element as provided in Article 10.5 (commencing

with Section 65560) of this chapter.

(f) A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis and seiches.

(g) A noise element in quantitative, numerical terms, showing contours of present and projected noise levels associated with all existing and proposed major transportation elements. These include but are not limited to the following:

(1) Highways and freeways,

(2) Ground rapid transit systems,

(3) Ground facilities associated with all airports operating under a permit from the State Department of Aeronautics.

These noise contours may be expressed in any standard acoustical scale which includes both the magnitude of noise and frequency of its occurrence. The recommended scale is sound level A, as measured with A-weighting network of a standard sound level meter, with corrections added for the time duration per event and the total number of events per 24-hour period.

Noise contours shall be shown in minimum increments of five decibels and shall be continued down to 65 db(A). For regions involving hospitals, rest homes, long-term medical or mental care, or outdoor recreational areas, the contours shall be continued down to 45 db(A).

Conclusions regarding appropriate site or route selection alternatives or noise impact upon compatible land uses shall be included in the general plan.

The state, local, or private agency responsible for the construction or maintenance of such transportation facilities shall provide to the local agency producing the general plan, a statement of the present and projected noise levels of the facility, and any information which was used in the development of such levels.

SENATE BILL 520

Earthquake Protection Passed December 1, 1972

SB 520, as amended, Alquist. Earthquake protection.

Increases the membership of the State Mining and Geology Board from 9 to 11 persons and declares that persons with specified occupations should be selected for membership on the board. Designates the board as a policy and appeals board for the purposes of provisions re earthquake hazard zones.

Requires the State Geologist to delineate, by December 31, 1973, special studies zones encompassing certain areas of earthquake hazard. Requires State Geologist to compile maps delineating the special studies zones and to submit such maps to affected cities, counties, and state agencies for review and comment. Requires the State Geologist to continually review new geologic and seismic data and revise special studies zones and submit such revisions to affected cities, counties, and state agencies for review and comment. Appropriates $100,000 for such purposes. Requires cities, counties, and state agencies to submit their comments to board.

Requires cities and counties to exercise specified approval authority with respect to real estate developments or structures for human occupancy within such delineated zones. Requires applicants for a building permit within such zone to be charged a fee according to a fee schedule established by the board. Limits maximum amount of such fee. Provides for retention of 1/2 of the proceeds of any such fee by the city or county having jurisdiction and tranfer of 1/2 to the state.

The people of the State of California do enact as follows:

SECTION 1. Section 660 of the Public Resources Code is amended to read:

660. There is in the department a State Mining and Geology Board, consisting of 11 members appointed by the Governor, subject to confirmation by the Senate, for terms of four years and until their successors are appointed and qualified, The State Mining and Geology Board shall also serve as a policy and appeals board for the purposes of Chapter 7.5 (commencing with Section 2621) of Division 2.

SEC.2. Section 661 of the Public Resources Code is amended to read:

661. Members of the board shall be selected from citizens of this state associated with or having broad knowledge of the mineral industries of this state, of its geologic resources, or of related technical and

scientific fields, to the end that the functions of the board as specified in Section 667 are conducted in the best interests of the state. Among the 11 members, two should be mining geologists, mining engineers, or mineral economists, one should be a structural engineer, one should be a geophysicist, one should be an urban or regional planner, one should be a soils engineer, two should be geologists, one should be a representative of county government, and at least two shall be members of the public having interest in and knowledge of the environment.

SEC.3. Section 662 of the Public Resources Code is amended to read:

662. The terms of the members of the board in office when this article takes effect in 1965 shall expire as follows: one member January 15, 1966; two members January 15, 1967; and two members January 15, 1968. The terms shall expire in the same relative order as to each member as the term for which he holds office before this article takes effect. The terms of the two additional members first appointed pursuant to the amendment of this section at the 1968 Regular Session of the Legislature shall commence on January 15, 1969. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1970 Regular Session of the Legislature shall commence on January 15, 1971, but the term of one of such additional members, who shall be designated by the Governor, shall expire on January 15, 1974. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1972 Regular Session of the Legislature shall commence on January 15, 1973, but the term of one of such additional members, who shall be designated by the Governor, shall expire on January 15, 1976.

SEC. 4. Chapter 7.5 (commencing with Section 2621) is added to Division 2 of the Public Resources Code, to read:

CHAPTER 7.5. HAZARD ZONES

2621. This chapter shall be known and may be cited as the Alquist-Priolo Geologic Hazard Zones Act.

2621.5. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties, as well as to implement such general plan as may be

in effect in any city or county. The Legislature declares that the provisions of this chapter are intended to provide policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibility to provide for the public safety in hazardous fault zones.

2622. In order to assist cities and counties in their planning, zoning, and building-regulation functions, the State Geologist shall delineate, by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults, or segments thereof, as he deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. Such special studies zones shall ordinarily be one-quarter mile or less in width, except in circumstances which may require the State Geologist to designate a wider zone.

Pursuant to this section, the State Geologist shall compile maps delineating the special studies zones and shall submit such maps to all affected cities, counties, and state agencies, not later than December 31, 1973, for review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 90 days. Within 90 days of such review, the State Geologist shall provide copies of the official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

The State Geologist shall continually review new geologic and seismic data and shall revise the special studies zones or delineate additional special studies zones when warranted by new information. The State Geologist shall submit all such revisions to all affected cities, counties, and state agencies for their review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 30 days. Within 30 days of such review, the State Geologist shall provide copies of the revised official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

2623. Within the special studies zones delineated pursuant to Section 2622, the site of every proposed new occupancy shall be approved by the city or county having jurisdiction over such lands in accordance with

policies and criteria established by the State Mining and Geology Board and the findings of the State Geologist. Such policies and criteria shall be established by the State Mining and Geology Board not later than December 31, 1973. In the development of such policies and criteria, the State Mining and Geology Board shall seek the comment and advice of affected cities, counties, and state agencies. Cities and counties shall not approve the location of such a development or structure within a delineated special studies zone if an undue hazard would be created, and approval may be withheld pending geologic and engineering studies to more adequately define the zone or hazard. If the city or county finds that no undue hazard exists, geologic and engineering studies may be waived, with approval of the State Geologist, and the location of the proposed development or structure may be approved.

2624. Nothing in this chapter is intended to prevent cities and counties from establishing policies and criteria which are stricter than those established by the State Mining and Geology Board, nor from imposing and collecting fees in addition to those required under this chapter.

2625. Each applicant for a building permit within a delineated special studies zone shall be charged a reasonable fee according to a fee schedule established by the State Mining and Geology Board. Such fees shall be set in an amount sufficient to meet, but not to exceed, the costs to state and local government of administering and complying with the provisions of this chapter. Such fee shall not exceed one-tenth of 1 percent of the total valuation of the proposed building construction for which the building permit is issued, as determined by the local building official. One-half of the proceeds of such fees shall be retained by the city or county having jurisdiction over the proposed development or structure for the purpose of implementing this chapter, and the remaining Fund.

SEC. 5. There is hereby appropriated from the General Fund in the State Treasury to the Department of Conservation the sum of one hundred thousand dollars ($100,000) for the purposes of Section 2622 of the Public Resources Code.

SENATE BILL 520 EARTHQUAKE PROTECTION

LEGISLATIVE COUNSEL'S DIGEST

SB 520, as introduced, Alquist. Earthquake protection.

Increases the membership of the State Mining and Geology Board from 9 to 11 persons and declares that persons with specified occupations should be selected for membership on the board.

Requires the State Geologist to delineate, by December 31, 1973, special studies zones encompassing certain areas of earthquake hazard. Appropriates $100,000 for such purpose.

Requires cities and counties to exercise specified approval authority with respect to real estate developments or structures for human occupancy within such delineated zones. Requires applicants for a development or building site within such zone to be charged a fee according to a fee schedule established by the board. Provides for allocating one-half of the proceeds of any such fee to the city or county having jurisdiction and one-half to the state. Creates the Fault-Zone Account in the General Fund for the deposit of the states' share of fee proceeds.

The people of the State of California do enact as follows:

SECTION 1. Section 660 of the Public Resources Code is amended to read:

660. There is in the department a State Mining and Geology Board, consisting of 11 members appointed by the Governor, subject to confirmation by the Senate, for terms of four years and until their successors are appointed and qualified.

SEC.2. Section 661 of the Public Resources Code is amended to read:

661. Members of the board shall be selected from citizens of this state associated with or having broad knowlege of the mineral industries of this state, of its geologic resources, or of related technical and scientific fields, to the end that the functions of the board as specified in Section 667 are conducted in the best interests of the state. Among the 11 members, at least one should be a mining geologist, mining engineer, or mineral economist, at least one should be a

structural engineer, at least one should be a seismologist, at least one should be an architect, at least one should be a soils engineer, at least one should be a geologist with knowledge of the behavior of soils, and at least two shall be members of the public having an interest in and knowledge of the environment.

SEC. 3. Section 662 of the Public Resources Code is amended to read:

662. The terms of the members of the board in office when this article takes effect in 1965 shall expire as follows: one member January 15, 1966; two members January 15, 1967; and two members January 15, 1968. The terms shall expire in the same relative order as to each member as the term for which he holds office before this article takes effect. The terms of the two additional members first appointed pursuant to the amendment of this section at the 1968 Regular Session of the Legislature shall commence on January 15, 1969. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1970 Regular Session of the Legislature shall commence on January 15, 1971, but the term of one of such additional members, who shall be designated by the Governor, shall expire on January 15, 1974. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1972 Regular Session of the Legislature shall commence on January 15, 1976.

SEC. 4. Chapter 7.5 (commencing with Section 2621) is added to Division 2 of the Public Resources Code, to read:

CHAPTER 7.5. HAZARD ZONES

2621. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties, as well as to implement such general plan as may be in effect in any city or county. The Legislature hereby declares that it is its intention by these provisions to establish criteria and standards to guide cities or counties in the exercise of their responsibility to provide an adequate degree of public safety in hazardous fault zones.

2622. In order to assist cities and counties in their planning, zoning, and building-regulation functions, the State Geologist shall delineate,

by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults, or segments thereof, as he deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. Such special studies zones shall ordinarily be one-quarter mile or less in width, except in unusual circumstances which may require the State Geologist to designate a wider zone.

2623. Within the special studies zones delineated pursuant to Section 2622, the site of every proposed new real estate development or structure for human occupancy shall be approved by the city or county having jurisdiction over such lands in accordance with policies and criteria established by the State Mining and Geology Board pursuant to the findings of the State Geologist. Cities and counties shall not approve the location of such a development or structure within a delineated special studies zone if an undue hazard would be created, or approval may be withheld pending geologic and engineering studies to more adequately define the zone of hazard. If the city or county then finds that no undue hazard exists, the location of the proposed development or structure may be approved.

2624. Each applicant for a development or building site within a delineated special studies zone shall be charged a reasonable fee according to a fee schedule established by the State Mining and Geology Board. Such fees shall be set in an amount sufficient to meet the costs to state and local government of administering and complying with the provisions of this chapter. One-half of the proceeds of such fees shall be retained by the city or county having jurisdiction over the proposed development or structure for the purpose of implementing this chapter, and the remaining one-half of the proceeds shall be deposited in the Fault-Zone Account in the General Fund in the State Treasury, which account is hereby created, to be used exclusively for the purposes of this chapter.

SEC. 5. There is hereby appropriated from the General Fund in the State Treasury to the Department of Conservation the sum of one hundred thousand dollars ($100,000) for the purposes of Section 2622 of the Public Resources Code.

ASSEMBLY BILL 407 GEOLOGIC HAZARDS

LEGISLATIVE COUNSEL'S DIGEST

AB 407, as introduced, Priolo (P. & L.U.). Land, geological hazards.

Requires the Division of Mines and Geology of the Department of Conservation to designate areas of state lying along specified faultlines as fault movement hazard zones and formulate and transmit to cities and counties criteria for local land use within such areas.

Requires each city and county having jurisdiction over any land within such zones to adopt a local fault movement hazard lands plan, as part of the seismic safety element of its general plan, consistent with division's criteria and requires each such city and county to adopt a fault movement hazard lands zoning ordinance consistent with such plan.

The people of the State of California do enact as follows:

SECTION 1. Section 65302 of the Government Code as amended by Section 1.5 of Chapter 1803 of the Statutes of 1971, is amended to read:

65302. The general plan shall consist of a statement of development policies and shall include a diagram or diagrams and text setting forth objectives, principles, standards, and plan proposals. The plan shall include the following elements:

(a) A land-use element which designates the proposed general distribution and general location and extent of the uses of the land for housing, business, industry, open space, including agriculture, natural resources, recreation, and enjoyment of scenic beauty, education, public buildings and grounds, solid and liquid waste disposal facilities, and other categories of public and private uses of land. The land-use element shall include a statement of the standards of population density and building intensity recommended for the various districts and other territory covered by the plan. The land-use element shall also identify areas covered by the plan which are subject to flooding and shall be reviewed annually with respect to such areas.

(b) A circulation element consisting of the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities, all correlated with the land-use element of the plan.

(c) A housing element, to be developed pursuant to regulations established under Section 37041 of the Health and Safety Code, consisting of standards and plans for the improvement of housing and for provision of adequate sites for housing. This element of the plan shall make adequate provision for the housing needs of all economic segments of the community.

(d) A conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources. That portion of the conservation element including waters shall be developed in coordination with any countywide water agency and with all district and city agencies which have developed, served, controlled or conserved water for any purpose for the county or city for which the plan is prepared. The conservation element may also cover:

(1) The reclamation of land and water.

(2) Flood control.

(3) Prevention and control of the pollution of streams and other waters.

(4) Regulation of the use of land in stream channels and other areas required for the accomplishment of the conservation plan.

(5) Prevention, control, and correction of the erosion of soils, beaches, and shores.

(6) Protection of watersheds.

(7) The location, quantity and quality of the rock, sand and gravel resources.

(e) An open-space element as provided in Article 10.5 (commencing with Section 65560) of this chapter.

(f) A seismic safety element consisting of a fault movement hazard plan as provided in Article 10.7 (commencing with Section 65580) of this chapter and an identification and appraisal of seismic hazards including, but not limited to, susceptibility to surface

ruptures from faulting, ground shaking, ground failures, or effects of seismically induced waves such as tsunamis and seiches.

(g) A noise element in quantitative, numerical terms, showing contours of present and projected noise levels associated with all existing and proposed major transportation elements. These include but are not limited to the following:

(1) Highways and freeways,

(2) Ground rapid transit systems,

(3) Ground facilities associated with all airports operating under a permit from the State Department of Aeronautics.

These noise contours may be expressed in any standard acoustical scale which includes both the magnitude of noise and frequency of its occurrence. The recommended scale is sound level A, as measured with A-weighting network of a standard sound level meter, with corrections added for the time duration per event and the total number of events per 24-hour period.

Noise contours shall be shown in minimum increments of five decibels and shall be continued down to 65 db(A). For regions involving hospitals, rest homes, long-term medical or mental care, or outdoor recreational areas, the contours shall be continued down to 45 db(A).

Conclusions regarding appropriate site or route selection alternatives or noise impact upon compatible land uses shall be included in the general plan.

The state, local, or private agency responsible for the construction or maintenance of such transportation facilities shall provide to the local agency producing the general plan, a statement of the present and projected noise levels of the facility, and any information which was used in the development of such levels.

(h) A scenic highway element for the development, establishment, and protection of scenic highways pursuant to the provisions of Article 2.5 (commencing with Section 260) of Chapter 2 of Division 2 of the Streets and Highways Code.

The requirements of this section shall apply to charter cities.

SEC. 2. Section 65553 of the Governeent Code is amended to read:

65553. No street shall be improved, no sewers or

connections or other improvements shall be laid or public building or works including school buildings constructed within any territory for which the legislative body has adopted a specific plan regulating the use of open-space land or the use of land within a fault movement hazard zone until the matter has been referred to the planning agency for a report as to conformity with such specific plan, a copy of the report has been filed with the legislative body, and a finding made by the legislative body that the proposed improvement, connection or construction is in conformity with the specific plan. Such report shall be submitted to the legislative body within ~~(40)~~ days after the matter was referred to the planning agency. The requirements of this section shall not apply in the case of a street which was accepted, opened, or had otherwise received the legal status of a public street prior to the adoption of the specific plan.

SEC. 3. Article 10.7 (commencing with Section 65580) is added to Chapter 3 of Title 7 of the Government Code, to read:

Article 10.7. Fault Movement Hazard Lands

65580. The Legislature finds and declares as follows:

(a) There are areas within the state where, due to fault movement conditions, the risk of injury to persons and property is necessarily involved in land use and the value of the lands for open-space use, as defined in subdivision (e) of Section 65560 is such that such areas should either remain in an essentially undeveloped state or development should be severely restricted.

(b) The regulation of land uses within areas of significant fault movement hazard is necessary for the promotion of the health, safety, and welfare of the people of this state.

65581. Every city and county having jurisdiction over any area, or portion thereof, designated as a fault movement hazard zone by the Division of Mines and Geology of the Department of Conservation pursuant to Chapter 8 (commencing with Section 2650) of Division 2 of the Public Resources Code shall, by June 30, 1974, prepare and adopt a local fault movement hazard lands plan for the regulation of land use in such area.

The plan shall be consistent with the land-use criteria formulated by the Division of Mines and Geology for the area and shall constitute the fault movement hazard plan of the seismic safety element of the general plan required by subdivision (f) of Section 65302.

65582. Every local fault movement hazard lands plan shall contain an action program consisting of specific programs which the legislative body intends to pursue in implementing such plan.

65583. Any action by a city or county by which land designated a fault movement hazard area by the Division of Mines and Geology or any interest therein is acquired or disposed of or its use restricted or regulated, whether or not pursuant to this title, shall be consistent with its fault movement hazard lands plan.

65584. No building permit may be issued, no subdivision map approved, and no fault movement hazard lands zoning ordinance adopted, unless the proposed construction, subdivision, or ordinance is consistent with the local fault movement hazard lands plan.

65585. If any provision of this article or the application thereof to any person is held invalid, the remainder of the article and the application of such provision to other persons shall not be affected thereby.

SEC. 4. Section 65800 of the Government Code is amended to read:

65800. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules and regulations by counties and cities, as well as to implement such general plan as may be in effect in any such county or city. Except as provided in Article 4 (commencing with Section 65910) and Article 4.2 (commencing with Section 65930) of this chapter, the Legislature declares that in enacting this chapter it is its intention to provide only a minimum of limitation in order that counties and cities may exercise the maximum degree of control over local zoning matters.

SEC. 5. Section 65860 of the Governement Code, as amended by Chapter 1446 of the Statutes of 1971, is amended to read:

65860. (a) Except as otherwise provided in Section 65930 with respect to fault movement hazard lands zoning, county or city zoning ordinances shall be consistent with the general plan of the

county or city by January 1, 1973.

(b) Any resident or property owner within a city or a county, as the case may be, may bring an action in the superior court to enforce compliance with the provisions of subdivision (a). Any such action or proceedings shall be governed by Chapter 2 (commencing with Section 1084) of Title 2 of Part 3 of the Code of Civil Procedure. Any action or proceedings taken pursuant to the provisions of this subdivision shall be taken within six months of January 1, 1973, or within 90 days of the enactment of any new zoning ordinance or the amendment of any existing zoning ordinance as to such amendment or amendments.

SEC. 6. Article 4.2 (commencing with Section 65930) is added to Chapter 4 of Title 7 of the Government Code, to read:

Article 4.2 Fault Movement Hazard Lands Zoning

65930. Every city or county having jurisdiction over any area, or portion thereof, designated as a fault movement hazard zone by the Division of Mines and Geology of the Department of Conservation pursuant to Chapter 8 (commencing with Section 2650) of Division 2 of the Public Resources Code shall, by December 31, 1974, adopt a fault movement hazard lands zoning ordinance consistent with the local fault movement hazard lands plan adopted pursuant to Article 10.7 (commencing with Section 65580) of Chapter 3 of this title.

65931. Variances from the terms of the fault movement hazard lands zoning ordinance shall be granted only when, because of special circumstances applicable to the property, the strict application of the zoning ordinance deprives such property of privileges enjoyed by other property in the vicinity and under identical zoning classification.

Any variance granted shall be subject to such conditions as will assure that the adjustment thereby authorized shall not constitute a grant of special privileges inconsistent with the limitations upon other properties in the vicinity and zone in which such property is situated.

SEC. 7. Chapter 8 (commencing with Section 2650) is added to Division 2 of the Public Resources Code, to read:

CHAPTER 8. FAULT MOVEMENT HAZARD LANDS

2650. As used in this chapter, "fault movement" means the breaking or shearing of the earth's crust due to slippage along a faultline.

2651. The division shall designate areas of the state which lie along the San Andreas, San Jacinto, Hayward, Calaveras, and White Wolf faultlines and constitute areas of significant fault movement hazard as fault movement hazard zones.

In designating fault movement hazard zones, the division shall specify the distance from the faultline within which, in its determination, there exists a significant risk of death or injury to persons or damage to property directly caused by fault movement.

2652. The division shall formulate criteria for local land use within a designated fault movement hazard zone and shall transmit such criteria to each city and county having jurisdiction over lands lying within any such zone on or before December 31, 1973. Such criteria shall provide local government with land use safety standards and land use regulation guidelines in the formulation of a local fault movement hazard lands plan.

SEC. 8. Section 3 of Chapter 1657 of the Statutes of 1967 is amended to read:

Sec. 3. Except as provided in Article 10.5 (commencing with Section 65560) and Article 10.7 (commencing with Section 65580) of Chapter 3 and Article 4 (commencing with Section 65910) and Article 4.2 (commencing with Section 65930) of Chapter 4 of Title 7 of the Government Code, the Legislature does not intend by the enactment of this act to interfere, either directly or indirectly, with local control zoning.

SENATE BILL 1314

Construction in Active Fault Zones

PREAMBLE: Potential for life and property damage from earthquakes in California mounts with increased urbanization. Losses result from a mismatch of land use and specific siting and design with local ground

behavior, principally due to (1) inadequate scientific knowledge of earthquake processes; (2) public unawareness of hazards; and (3) government inaction in reducing known risks. The proposed legislation would initiate government action to reduce earthquake damage and would foster a growing public awareness of earthquake hazards.

Earthquake losses most often are caused by damage of structures due to (1) ground displacement along a fault rupture; (2) vibrational weakening produced by strong ground shaking; (3) ground failure such as landslides, lateral spreading, cracking, etc.; (4) tectonic land and sea level changes; and (5) inundation by seismic sea waves. Of these hazards, the first is currently the most easily predicted and corrected by intelligent land use regulation. While it does not appear economically feasible at the present time to design most structures to withstand significant ground displacement, it is possible and prudent to control the location of structures in zones of active faults where human life and major public investments may be endangered during earthquakes.

For this purpose, the proposed legislation requires that all proposals for new construction for human occupancy and for public service facilities in the vicinity of active faults shall meet specified standards to qualify for approval by city and county planning commissions. Commissions will consider specific applications, following approval by newly created local Technical Review Boards based on geological and engineering reports submitted by applicants that demonstrate an undue hazard would not be created. Authorizes $100,000 for the California Division of Mines and Geology to delineate active fault traces and fault zones. Establishes a State Policy and Appeals Board under the State Office of Planning and Research and specifies its composition and duties.

PROPOSED LEGISLATION

A. *Definitions: For the purposes of this Section, the following definitions will pertain:*

1. Active fault trace is the surface location of an earth fracture plane, along which there has been tectonic displacement of the two sides relative to one another and parallel to the fracture, and along which there is a reasonable likelihood that displacement of the ground surface could reoccur within 200 years.

2. Active fault zone is the linear area enclosed within the outermost of a group of clearly related faults that mark a zone of crustal weakness. Such a zone generally is one-quarter mile or less in width centered approximately over one or more active fault traces; in unusual circumstances, a wider zone may be designated where known active traces, related to the same fault, occur more than one-quarter mile apart.

3. Known active fault traces shall include, but not be limited to, the San Andreas, San Jacinto, Hayward, Calaveras, White Wolf, and San Fernando faults.

4. Known active fault zones shall include, but not be limited to, the San Andreas, San Jacinto, Hayward, Calaveras, and Newport-Inglewood fault zones.

B. It is the intent of this Section to prohibit the construction of structures for human occupancy and for public service facilities (highways, bridges, dams, utilities, etc.) on an active fault trace or where an undue hazard would be created, except where it shall be deemed essential to do so for the public welfare. For this purpose, all actions to zone or subdivide land, all applications for buildings of greater occupancy than detached single family residences, and of public service facilities anywhere within an active fault zone shall be reviewed and require approval as specified herein. Otherwise, exempted single family residences shall also be reviewed as specified herein if they are to be located within 200 feet of an active fault trace shown by the California Division of Mines and Geology.

C. Preparation of Official Maps of Active Fault Traces and Active Fault Zones.

1. The California Division of Mines and Geology shall compile maps, at the largest practicable scale, showing the location of all known active fault traces and active fault zones to the degree of accuracy permitted by the state of knowledge. The maps shall be

compiled from all available federal, state, local, and private data, which will be filed and maintained by the Division and will be accessible for public inspection.

2. The maps shall be submitted to the Mining and Geology Board by September 30, 1973 for review. If approved and endorsed by the Mining and Geology Board, the California Division of Mines and Geology will transmit the maps to each city and county having jurisdiction over lands lying within any such zone on or before December 31, 1973.

3. The sum of $100,000 is hereby appropriated from _____ to enable the California Division of Mines and Geology to comply with this section.

4. The California Division of Mines and Geology shall continually review new geologic and seismic data and shall prepare and transmit revisions to the official maps of active fault traces and zones as soon as it is warranted by new information and as they are endorsed by the Mining and Geology Board.

D. Applications or proposals for new construction, as specified in Section B, shall be submitted to the appropriate local planning commission or council for review and approval. Such body, on the advice of a Technical Review Board shall grant approval for zoning, subdivision, or construction only when all of the following conditions are met: (1) upon an affirmative recommendation of the Technical Review Board, based on a review of geological and engineering reports submitted by the applicant and directed to the problem of surface faulting; (2) in their opinion, an undue hazard would not result from the zoning, subdivision of lands, or construction; and (3) the proposal is consistent with Seismic Safety Element provisions of the General Plan and its implementing zoning ordinances, or with Active Fault Zone policies and guidelines established by the State Policy and Appeals Board if they are more restrictive. Furthermore:

1. All repairs or reconstruction of existing structures and facilities as defined in Section B that, within any one year, exceeds 25% of the market value of the structure or facility, similarly must be submitted for approval.

2. The Technical Review Board shall consist of a city planner, an architect, a geologist, a soil engineer, and a structural engineer--

all qualified professionals and all staff members or officials of the city or county. In the event a city does not directly employ staff qualified in all the disciplines specified for the Board, members may be appointed on contract with the county if they are staff members or officials of the county. Should the county lack the full range of expertise specified, or the city choose not to contract for the needed disciplines with the county government, the city will contract with the State Technical Advisory Commission to perform the required review function. Similarly, should a county lack the expertise specified, the county shall contract with the State Technical Advisory Commission for review.

3. Any applicant or aggrieved party may appeal to the city or county governing body the decisions of a lesser body or staff member administering the provisions of this law.

E. A State Policy and Appeals Board will be established under the State Office of Planning and Research. The Board shall consist of ten professional members--three geologists, three planners, two structural engineers, one soil engineer, one architect--and one public member. The geologists shall be appointed as follows; one member shall be selected from the State Mining and Geology Board, one member nominated by the California Academy of Sciences, and one member nominated by the Association of Engineering Geologists; the planning members shall consist of the State Planning Officer as Chairman of the Board, one member nominated by the American Institute of Planners, and one member by the American Society of Planning Officials; one structural engineer and one soil engineer shall be appointed from the staff of the State Office of General Services, and one structural engineer will be nominated by the Structural Engineers Association of California; and one member will be appointed by the Governor from the public at large.

The duties of the State Policy and Appeals Board shall be as follows:

1. Appoint a technically select, six-member Technical Advisory Commission with one member from each of the disciplines of urban planning, geology, seismology, architecture, soil engineering, and structural engineering respectively. The Commission's responsibilities will be to technically review all geologic and engineering reports submitted in support of applications for zoning, subdivision, or construction

as they relate to active fault zones and fault traces as requested by city or county planning commissions, by the Policy and Appeals Board, or by appropriate local, State, or Federal agencies for technical recommendations.

2. Recommend broad, state-wide guidelines and policies for land use within active fault zones and on active fault traces.

3. Serve as an Appeals Board for any applicant or concerned party of the decisions by cities or counties on questions of compliance with State Policy and Appeals Board standards and guidelines. Where an appeal is sustained, the Board may require local government to conform.

4. Review land use plans and zoning regulations devised by cities and counties in active fault zones and work with local jurisdictions toward establishing state-wide equity and conformance of land use in active fault zones. Where local government plans and zoning are less restrictive than recommended State policy, the State Policy and Appeals Board may require local conformity with State policy.

5. Establish a standard fee schedule to be levied on applicants to reimburse the cost of technical review and appeals at the State level. Other expenses incurred by the State Policy and Appeals Board shall be appropriated annually by the Legislature. Local agencies may establish appropriate fees on applications to cover the cost of local review.

F. All proposed construction by State and local governments anywhere within active fault zones must comply with the provisions of this legislation. Construction may proceed only after approval by the State Policy and Appeals Board and after review of geologic and engineering reports by the State Technical Advisory Commission. The Federal government also will be urged to submit their proposed construction plans for review by the State Commission and Board.

SENATE BILL 1206

Earthquake Protection

SB 1206, as introduced, Alquist (G.O.). Earthquake protection. Adds Sec. 682, P.R.C.

Creates in Department of Conservation a Policy and Appeals Board and specifies membership. Directs State Geologist to delineate a zone as specified centered on San Andreas Fault and along other faults deemed sufficiently well defined and active to constitute a potential hazard to structures from surface faulting.

Requires every proposed new real estate development or structure for human occupancy in the zone to be approved by the State Geologist on the basis of geological and engineering reports directed to the problem of surface faulting and in accordance with policies and criteria established by the Policy and Appeals Board. Prohibits approval if undue hazard would be created by the proposed development. Requires each applicant to pay fee established by the board, and declares legislative intent that costs of program shall be reimbursed by such fees.

The people of the State of California do enact as follows:

SECTION 1. Section 682 is added to the Public Resources Code, to read:

682. There is in the department a Policy and Appeals Board which consists of six members appointed by the Governor and serving at his pleasure, who shall be recognized authorities in the fields of geology, seismology, engineering, and planning.

The State Geologist shall delineate a zone one-quarter mile wide centered approximately on the most recently active traces of the San Andreas Fault, from Point Arena to the southern boundary of San Bernardino County, and along any other faults or segments thereof, that he deems sufficiently well defined and active to constitute a potential hazard to structure from surface faulting.

Within the delineated zone, every proposed new real estate development or structure for human occupancy shall be approved by the State

Geologist on the basis of geological and engineering reports directed to the problem of surface faulting and in accordance with policies and criteria established by the Policy and Appeals Board. The State Geologist shall not approve such a development or structure if an undue hazard would be created by the proposed development, giving consideration to the earthquake forces and movements identified in and justified by the geological and engineering reports. Each applicant shall be charged a fee according to a fee schedule established by the Policy and Appeals Board. It is the intent of the Legislature that the cost of the program established pursuant to this section shall be reimbursed by such fees.

SENATE BILL 895

Earthquake Safety

SB 895, as introduced, Alquist. Earthquake safety.

Requires counties and cities to collect a fee under the Strong-Motion Instrumentation Program from all applicants for building permits equal either to 0.007 percent of the valuation of the building as determined by the local building official or 50¢, whichever amount is higher, rather than requiring collection of such fee from all applicants for construction permits equal to 0.007 percent of the estimated construction cost of the structure. Defines the term "building" for purposes of the program.

To take effect immediately, urgency statute.

The people of the State of California do enact as follows:

SECTION 1. Section 2705 of the Public Resources Code is amended to read:

2705. All counties and cities shall collect a fee from all applicants for building permits. Each such fee shall be equal to 0.007 percent of the valuation of the building as determined by the local building official or fifty cents ($0.50), whichever amount is the higher.

"Building," for the purpose of this chapter, is any structure built for the support, shelter, or enclosure of persons, animals, chattels, or property of any kind.

SEC. 2. This act is an urgency statute necessary for the immediate preservation of the public peace, health, or safety within the meaning of Article IV of the Constitution and shall go into immediate effect. The facts constituting such necessity are:

This act is urgently needed for the protection of persons and property from earthquakes in that it effects changes in the funding of the Strong-Motion Instrumentation Program which is essential to the implementation of that program.

SENATE BILL 897

Property Taxation as Related to Geologic Hazards

SB 897, as introduced, Alquist. Property Taxation.

Establishes various procedures for reassessing property for purposes of property taxation found to be geologically defective or to have defects in the soil.

The people of the State of California do enact as follows:

SECTION 1. Section 155.2 is added to the Revenue and Taxation Code to read:

155.2 In consequence of any reassessment pursuant to Section 402.3, such reassessment shall be forthwith equalized and entered upon the assessment roll for the taxable year in question, the tax roll adjusted accordingly, and the amount of any reduction in taxes for such year upon the affected parcel shall be refunded or canceled.

SEC. 2. Section 402.2 is added to the Revenue and Taxation Code, to read:

402.2 In the assessment of property, the assessor shall consider the effect upon value of any geologic or soils defect or hazard in the land of which he may be aware. The report of a competent geologist, civil engineer, or soils engineer that the land may not be safely used for certain purposes otherwise allowed by law shall create a rebuttable

presumption, to be applicable in any administrative or judicial proceeding, to determine the accuracy of the assessment, that the use of the land is so restricted. If, in consequence of an application therefor by the owner pursuant to this section, the assessed value of land is reduced, the owner shall not thereafter develop the land for those uses which are determined to be unsafe in accordance with this section, unless the owner shall have first caused the unsafe conditions to be removed or overcome.

SEC. 3. Section 402.3 is added to the Revenue and Taxation Code, to read:

402.3. If it appears that the reduction in full cash value of property which has been damaged by earth or soil failure, including earthquakes, exceeds on thousand dollars ($1,000) as a result of such failures, the assessor shall, upon application of the owner, promptly reassess the property according to its full cash value immediately after the damage. In determining such full cash value, the assessor shall deduct from the value immediately preceding the failure the probable cost of repairing the land and structures damaged by the failure. In no instance shall the reduction in value due to such damages be greater than the value of the land and structures prior to the failure.

LEGISLATION PERTAINING TO HOUSING AND SUBDIVISIONS

ASSEMBLY BILL 2805

Subdivided Lands

An act to amend Section 11018.2 of the Business and Professions Code, relating to subdivided lands.

AB 2805, as introduced, McAlister (P. & L.U.). Subdivided lands. Amends Sec. 11018.2, B. & P.C.

Requires that geological reports, relating to lots or parcels in a subdivision, be given subsequent bona fide purchasers. Requires that

copy of report be attached to property deed. Requires report to be separate document from Real Estate Commissioner's public report.

The people of the State of California do enact as follows:

SECTION 1. Section 11018.2 of the Business and Professions Code is amended to read:

11018.2. No person shall sell or lease, or offer for sale or lease in this state any lots or parcels in a subdivision without first obtaining a public report from the commissioner, except that the commissioner shall waive the provisions of this section, in writing, for expressly zoned industrial subdivisions which are limited in use to industrial purposes and commercial leases of parcels in a shopping center.

As used in this section, "shopping center" means a group of commercial establishments, planned, developed, owned, or managed as a unit, with offstreet parking provided on the property of the shopping center.

A geological report shall be given each subsequent bona fide purchaser of the lot or parcel. A copy of the geological report shall be attached to the deed of the property. The geological report shall be a separate document from the public report.

ASSEMBLY BILL 1176

Geologic Safety of Subdivisions

AB 1176, as amended, Ketchum (P. & L.U.). Subdivisions: geologic safety.

Amends various secs., B. & P.C., H. & S.C.

Revises provisions relating to subdivisions to require geological report in addition to soil reports. Requires Commission of Housing and Community Development to adopt specified rules and regulations relating to soil and geological reports.

Makes related changes.

The people of the State of California do enact as follows:

SECTION 1. It is the intent and purpose of the Legislature to extend in the interest of public safety the present requirement for soil investigations of proposed subdivision sites for the possible presence of expansive soils, to include investigation of all geologic conditions for the possible presence of other geologic hazards such as active or potentially active faults, mudflows, landslides, subsidence and rapid erosion. Ordinances with similar intent are currently in effect in several political subdivisions of the state, and where adequately conceived and enforced, have been notably successful in the prevention of loss of life and property from hazardous geologic conditions and processes. This act is intended to afford similar protection to all areas of the state.

SEC. 2. Section 11010 of the Business and Professions Code is amended to read:

11010. Prior to the time when subdivided lands are to be offered for sale or lease, the owner, his agent or subdivider shall notify the commissioner in writing of his intention to sell or lease such offering.

The notice of intention shall contain the following information:

(a) The name and address of the owner.

(b) The name and address of the subdivider.

(c) The legal description and area of lands.

(d) A true statement of the condition of the title to the land, particularly including all encumbrances thereon.

(e) A true statement of the terms and conditions on which it is intended to dispose of the land, together with copies of any contracts intended to be used.

(f) A true statement of the provisions, if any, that have been made for public utilities in the proposed subdivision, including water, electricity, gas, telephone, and sewerage facilities.

(g) A true statement of the use or uses for which the proposed subdivision will be offered.

(h) A true statement of the provisions, if any, limiting the use or occupancy of the parcels in the subdivision.

(i) A true statement of the maximum depth of fill used, or proposed to be used on each lot, and a true statement on the soil conditions in the subdivision supported by soil engineering reports showing the soil has been, or will be, prepared in accordance with the recommendations of a registered civil engineer.

(j) A geologic report prepared or approved by a registered geologist certified in engineering geology, if such report is prepared pursuant to Section 17953 of the Health and Safety Code.

(k) A true statement of the amount of indebtedness which is a lien upon the subdivision or any part thereof, and which was incurred to pay for the construction of any onsite or offsite improvement, or any community or recreational facility.

(l) A true statement or reasonable estimate, if applicable, of the amount of any indebtedness which has been or is proposed to be incurred by an existing or proposed special district, entity, taxing area or assessment district, within the boundaries of which, the subdivision, or any part thereof, is located, and which is to pay for the construction or installation of any improvement or to furnish community or recreational facilities to such subdivision, and which amounts are to be obtained by ad valorem tax or assessment, or by a special assessment or tax upon the subdivision, or any part thereof.

(m) Such other information as the owner, his agent, or subdivider, may desire to present.

SEC. 3. Section 11018.4 of the Business and Professions Code is amended to read:

11018.4. In addition to the grounds for the denial of a public report as set forth in Section 11018, the commissioner shall deny the issuance of a public report if the subdivider fails to demonstrate that:

(a) The soil within the subdivision has been, or will be, prepared in accordance with the recommendations of a registered civil engineer in such a manner that structural damage is not likely to result.

(b) Unstable or hazardous geologic conditions have been, or will be, adequately considered in the preparation of building sites in accordance with the recommendations of a registered civil engineer as based on the report of the registered geologist so as to avoid, prevent, or minimize potential structural damage.

SEC. 4. Section 11568 of the Business and Professions Code is amended to read:

11568. When a soil report or a soil and geologic report has been prepared, this fact shall be noted on the final map, together with the date of the report and the name of the engineer or the engineer and geologist making the report.

SEC. 5. Section 17953 of the Health and Safety Code is amended to read:

17953. The rules and regulations adopted by the commission pursuant to this part shall require, and each city, county, and city and county shall by ordinance require, a preliminary soil report prepared by a civil engineer who is registered by the state, and a preliminary geologic report prepared or approved by a geologist who is registered by the state and certified in engineering geology, based upon adequate test borings or excavations, and other investigations, of every subdivision, as defined in Sections 11535 and 11535.1 of the Business and Professions Code.

Either or both of these preliminary reports may be waived if the building department of the city, county, or city and county, or other enforcement agency charged with the administration and enforcement of the provisions of this part, shall determine that, due to the knowledge such department has as to the qualities of the soil and geologic conditions of the subdivision or lot, no preliminary analysis is necessary.

SEC. 6. Section 17954 of the Health and Safety Code is amended to read:

17954. If the preliminary soil or geologic report indicates the presence of critically expansive soils or other soil or geologic problems which, if not corrected or adequately planned for in design would lead to structural defects, the rules and regulations and the ordinance described in Section 17953 shall require a soil or geologic investigation of each lot in the subdivision.

The soil investigation shall be prepared by a civil engineer who is registered in this state. The geologic investigation shall be prepared or approved by a geologist registered in this state and certified in engineering geology. The civil engineer shall recommend

corrective action which is likely to prevent structural damage to each dwelling proposed to be constructed on the expansive soil or otherwise unstable or geologically hazardous site.

SEC. 7. Section 17955 of the Health and Safety Code is amended to read:

17955. The building department of each city, county, or city and county, or other enforcement agency charged with the administration and enforcement of the provisions of this part, shall approve the soil and geologic investigations if it determines that the recommended action is likely to prevent structural damage to each dwelling to be constructed. As a condition to the building permit, the rules and regulations and the ordinance described in Section 17953 shall require that the approved recommended action be incorporated in the construction of each dwelling. Appeal from such determination shall be to the local appeals board. The rules and regulations and the ordinance described in this section shall impose the same requirements and regulations as adopted by the commission and prescribed in Chapter 70 of the Uniform Building Code, 1970 edition, as adopted by the International Conference of Building Officials, unless the governing body of a city or county determines that more restrictive requirements or regulations are required because of local conditions. Before making any changes or modifications to impose more restrictive requirements or regulations, the governing body shall comply with the requirements of Section 17958.7.

SEC. 8. Section 17958.7 of the Health and Safety Code is amended to read:

17958.7. The governing body of a city or county before making any modifications or changes pursuant to Sections 17955 or 17958.5 shall make an express finding that such modifications or changes are needed. Such a finding shall be available as a public record and a copy, together with the modification or change, filed with the department. Nothing contained in this part shall be construed to require the governing body of any city or county to alter in any way building regulations enacted on or before the effective date of this section, except that a city, county, and city and county which adopts or enforces any local building regulations on or after November 23, 1971, shall

comply with the requirements of Sections 17953, 19754 and 17955.

The following recommendations for legislation pertaining to subdivisions was written under the auspices of the Advisory Group on Land Use Planning of the California Seismic Safety Committee.

I. Subdivions Regulations

The process by which local government allows land to be divided and sold in separate pieces under the supervision of the state is one of the most critical steps in the urban development process. Experience has indicated that once land has been divided, the resulting parcels, whether or not appropriate for development in terms of natural features including seismic problems, will come under great pressure for development. It is therefore very important to carefully analyze undivided acreages at the earliest possible stage with respect to seismic hazards to determine the suitability of land for subdivision. Mistakes during the subdivision process are virtually impossible to correct through other than the redevelopment process, an expensive method of correcting past errors. All cities and counties including charter cities and counties are required to adopt subdivision regulations.

> *"Two separate laws found in the Business and Professions Code of California govern the subdivision and sale of land--the Subdivision Map Act administered by the local jurisdiction in which the land is located, and the Subdivided Lands Law administered by the State Real Estate Commissioner. The Subdivision Map Act is concerned basically with procedures and requirements for recording subdivision maps, lot design, and physical improvements associated with creation of lots. The Subdivided Lands Law establishes procedures and requirements for offering lands and new subdivisions for sale or lease. Its primary purpose is to protect purchasers of land in new subdivisions from fraud, misrepresentation, or deceit."*

During the 1971 Legislative Session two companion bills were introduced, SB 29S and AB 1176, which would have accomplished the following:

1. Amend the Subdivision Lands Law to require a preliminary geologic report to be prepared by a registered geologist certified in engineering geology.

2. Require the Real Estate Commissioner to deny issuance of a public report for a subdivision if the subdivision fails to take into account hazardous geologic conditions. (State law prohibits the sale of subdivided lands unless a public report is furnished by the Real Estate Commissioner.)

3. Add to the Health and Safety Code the requirement that each city and county adopt an ordinance requiring preliminary geologic reports on all subdivisions pursuant to rules to be established by the Commission of Housing and Community Development.

4.

5. Restrict local building departments from issuing building permits where geologic problems are present unless they conform to the requirements of the Health and Safety Code. Also require adherence to Chapter 70 of the Uniform Building Code.

6. Permit more extensive geologic investigations to be required at the local level than are required by state law.

Although neither bill passed, these types of legislation appear necessary in order to insure that local cities and counties follow good practices in geologic investiations. The amendments should make more specific reference to seismic problems. As has been found with a previous amendment to the Health and Safety Code relating to soils reports, this type of requirement can be effective in seeing that the public interest is protected by local jurisdictions.

Also during the 1971 Legislative Session, Assembly Bill 2805 was introduced and referred to committee. This bill provided for amendments to the Subdivision Lands Law and specifically required that a geologic report be given to each purchaser of a lot or parcel and

that a copy of the report be attached to the deed of the property. This bill would ensure that prospective purchasers of new lots receive more detailed information than is now included in the real estate report furnished by the Real Estate Commissioner. Also, by attaching such a report to the deed to the property, it might (the should be made clear) become a recorded document and thereby be available to purchasers of resales.

What is needed is a device whereby at least all information included in the original Real Estate Commissioner's report at the time a lot is first sold is also made known to subsequent purchasers of that lot. It might be appropriate for a summary of the most important information from the real estate report to be recorded with the deed thereby flagging this information to all prospective purchasers.

It might also be possible to extend the provisions of the residential property report provided for by the Government Code. A residential property report includes information of local record pertaining to authorized use, occupancy and zoning classification. The intent of the law is to protect the unwary buyer of residential property against undisclosed restrictions on the use of the property. Presently, the residential property report is only required when a lot with a house is being sold. The provisions should be extended to require a residential property report on the transfer of vacant lots from one owner to another, and the sale or residential or non-residential parcels. Furthermore, the residential property requirement in state law is enabling in nature only and should be made mandatory in order to ensure protection to prospective purchasers. The scope of the report should be expanded to include seismic and other geologic information available at the local level.

1. Definition of Subdivision

(a) <u>Recommendation</u> -- The Subdivision Map Act should be amended to include all divisions of land into two or more parcels.

(b) <u>Implementation</u> -- Such an amendment would extend all soils and geologic requirements of the Map Act to all divisions. In some instances serious mistakes can be made even in dividing one parcel into two parcels. For instance, it is entirely possible for one of the parcels to be virtually useless because of geologic hazards.

Appropriate amendments should be made to Chapter 2 of the Business and Professions Code.

ABSTRACT

The Geologic Hazard Zones Act now requires local agencies to withhold approval of a development or structure within a delineated special studies zone if an undue hazard due to active faulting should be created, pending receipt of geologic/soils reports. Supplemental support of such action should be taken by amending the Real Estate Practices Act, the Subdivision Map Act and the Health and Safety Code. For example, soils and geologic-seismic investigations should be made mandatory under Subdivision Regulations. Recommendations made under Fault Hazard Control of this report are accordingly emphasized under Subdivision Regulations.

2. Soils and Geologic Investigations

Recommendation -- The Real Estate Practices Act, the Subdivision Map Act, and the Health and Safety Code should be amended to require geologic-seismic and soils reports on all subdivisions unless waived by a registered soils engineer and a registered geologist certified in engineering geology acting on behalf of the local jurisdiction. The content of such reports should conform to minimal requirements set forth by the State Division of Mines and Geology, or appropriate State commission or agency. The reports should be prepared by (1) registered civil engineers and (2) registered geologists certified in engineering geology. Each report should be reviewed and approved by an engineer or geologist acting on behalf of the local jurisdiction. The cost of review could be borne by the subdivision applicant. The local jurisdiction should have the option of employing its own geological expertise, whether it be by staff, contract of private geological services, or with other governmental agencies for review services approving development of local subdivisions.

This recommendation should receive the highest priority. Amendment of the Map Act, Health Code, and Real Estate Practices Act should accordingly supplement the requirements set forth under the Geologic Hazards Zone Act.

Justification and Implementation -- Urbanization is highly dependent upon strict economic considerations which have often prohibited proper geologic-seismic safeguards, even in communities which have taken the leadership in administering minimal geologic-seismic considerations for land development in geologically and seismically hazardous areas.

Legislation resulting from this recommendation must not be enabling in nature only, but be mandatory. The administration of local requirements for geologic-seismic reports must remain with the local government as part of this recommended legislation. Implementation by legislative action should proceed in the immediate and future legislative sessions.

3. Approval of Subdivisions

Recommendations

(a) The Real Estate Practices Act should be amended to:

(1) Permit the Real Estate Commissioner, upon the advice of the Division of Mines and Geology, or the local governing agency to deny issuance of a Real Estate report where reasonable doubt exists as to the safety of a subdivision with respect to geologic-seismic hazards.

(2) Require that the local agency advise the Real Estate Commissioner regarding the development of ungraded site lots and the need for further geologic investigation of such lots after preliminary grading for access roads of an approved subdivision has been completed. This action is currently permissive in nature only. It would be more protective to an individual lot purchaser if this procedure were not permissive but made mandatory on a statewide basis.

(b) The Subdivision Map Act should be amended to (1) require that cities and counties deny subdivision when reasonable doubt exists as to the geologic-seismic safety of individual lots or subdivisions, whether graded or ungraded; (2) geologic-seismic reports approving proposed developments be required by local ordinance for local government review and approval. These reports should be attached to the recorded deed to the property.

(3) Guidelines to define reasonable doubt with respect to geologic-seismic safety be included as part of any proposed legislation

amending the Subdivision Map Act. Such guidelines may well be patterned after those recommended by professional organizations such as the Association of Engineering Geologists. The guidelines must be compatible with guidelines for geologic-seismic factors controlling zoning in compliance with adopted General Plans and with policies and criteria cited by the Geologic Hazard Zones Act.

Justification -- Above proposed legislation is urgently needed today. Each year passing by witnesses continued development of geologically hazardous land. For example, construction of new subdivisions or single-family residences with minimum geologic-seismic control continues within the San Andreas Fault Zone. Homes are allowed to be rebuilt directly over the active Sylmar Fault segment of the active San Fernando Fault Zone. Some local agencies practice the policy of initially approving the development of new subdivisions with only minimal demonstration of the feasibility for development and with only one final control, and that is the approval for recordation of the final map after grading may already have been accomplished. Thus, feasibility of development with regard to geologic-seismic hazards need not be thoroughly established before the local planning agency gives approval for development.

Implementation -- Geologic-seismic controls must still be implemented at the local level which is emphasized by the Geologic Hazard Zones Act, but with guidelines and minimum standards enumerated in the Subdivision Map Act and the Real Estate Practices Act, as well as the minimal standards required by the Geologic Hazard Zones Act. Legislation on these matters is need.

4. Certification of Final Maps

Abstract

The Subdivision Map Act should require the local planning agency to disapprove a final map, or that portion of a final map affected by geologic-seismic hazards, and make mandatory that protective improvements be constructed as a condition of approval. As an alternative, any geologic hazard so disclosed could be noted on the final map and

erection of permanent structures be restricted to the approval of the local Building and Safety Department of each city or county as a condition of approval of the final map.

A review agency is needed for certification of final maps. Local agencies are encouraged to refer to their own staffs or back to their consultants rather than to the Division of Mines and Geology. However, where local agency planning departments do not have this capacity, legislation should be submitted in 1973 to permit the Real Estate Commissioner to use the Division of Mines and Geology staff for the review of consultant geologic-seismic reports relative to final map certification. Funding of this service could be accomplished by a fee charged to the developer remunerated to the Real Estate Commissioner through the offices of the local agency.

Recommendations

Amend the Subdivision Map Act to read:

(1) Where any soils and geologic investigations have been made with respect to a subdivision, they are to be noted on the face of the final subdivision or parcel map and the geologist, soils engineer, and supervising civil engineer preparing the investigation and final map are to certify that they have been prepared in conformance with good professional practice and guidelines set forth by the State Division of Mines and Geology, a State Seismic Safety Commission, or other State governmental agency.

The reviewing engineer and geologist for a city or county must also certify that they have reviewed the investigations and found that they comply with minimal state guidelines, policies and criteria.

(2) Amend the Subdivision Map Act to require that consultant geologists and soils engineers certify final maps where geologically hazardous areas still exist uncorrected by grading, even though a designed subdivision has been approved and graded. These areas are to be noted on the recorded map as "Geologically Hazardous Areas." The right to restrict the erection of permanent structures must be granted to the City/County. The local Building and Safety office will subsequently be notified and building permits in such areas will be denied until such time as the hazard is removed.

(3) Amend the Subdivided Lands Law and the Real Estate Practices Act to permit the Real Estate Commissioner to use the Division of Mines and Geology staff for the review of consultant geologic-seismic reports relative to final map certification in the event the local agency elects not to acquire a review staff of its own. Funding of this service could be accomplished through a fee structure paid by the developer to the local planning agency sufficient to allow defrayment of review costs for the Division's Geologic staff review and planning agency processing.

Justification

Some areas of a proposed subdivision may not be capable of being developed economically. Provisions should be made to allow development of the remainder of a proposed subdivision and still maintain at least minimal safeguards against undue geologic-seismic hazards.

II. Building and Grading Regulations

A. Introduction

Uniform Building Codes

Cities adopt building codes as they desire except for certain minimum standards required by state law such as the Housing Code, the Riley Act, the Field Act, and other provisions of the Health and Safety Code. Those codes generally adopted are modifications of the Uniform Building Code authored by the International Conference of Building Officials.

Chapter 70 of the Uniform Building Code provides for the requirement of soils and geologic reports. These provisions have been operating for some time, and similar provisions are becoming more or less convention for those cities and counties doing an adequate job of geologic review. However, though the U.B.C. is a very large step forward regarding the control of geologic hazards, it does have its limitations in that geologic and soil reports are required only for grading permits. (Chapter 29 of the U.B.C. does, however, allow for the requirement of foundation reports for the construction of structures.)

An improved version of the U.B.C. for general adoption by cities and counties throughout the State would include a provision allowing the building official to require geologically seismic reports for building permits where the site appears to be subject to a geologic-seismic hazard. Such a Section of the Code would prohibit the issuance of a building or grading permit if the City/County Engineer found that such action would have an adverse impact on property outside the site, as well as on site. The same Section should prohibit the issuance of a building or grading permit if the site is located in an area subject to hazard from landslide, settlement, or fault displacement, as determined by the City/County Engineer. Certain exceptions to these situations could be permitted where it can be demonstrated that problems can be solved, or that reports submitted by the applicant demonstrate that a site appears to be safe for the intended use, although the site is subject to a hazard of a geologic nature. Further, certain minor alterations or additions may be permitted. Where any construction is allowed in an area deemed hazardous, the applicant could record an agreement stating he relieves the City/County of liability.

Another improvement of the U.B.C. would be one that would permit the construction of a building or structure near or within an active earthquake fault, with certain limitations, two of which are that no building or structure shall be constructed over, or upon, the trace of an active earthquake fault shown on maps maintained by the City/County, and that all structures so placed are designed for potential seismic shaking.

B. Recommendations

1. Fault Hazard Control

The subject of Fault Hazard Control and applicable recommendations are covered more extensively in an earlier discussion on the subject.

General Plan Implementation

The Uniform Building Code could serve as an implementing device for a city or county's general plan of development. The General Plan which calls for local zoning ordinances controlling development in geologically

hazardous areas, including seismicity. Though the planning function at the early stage of zoning will take into consideration adverse geologic hazards, the grading stage inevitably will have the greater impact on the sound development of the land by incorporating design parameters sufficient to eliminate the inherent geologic hazard, whether they be active fault traces, seismic shaking and ground failure, or ordinary geologic hazards such as landsliding, subsidence, avalanches, etc.

2. *Grading Regulations*

State legislation should be enacted requiring (1) local governments to adopt the Uniform Building Code, incorporating grading regulations, Chapter 70, revised to include (a) seismic design standards based upon new knowledge gained before and after the San Fernando Earthquake of February 9, 1971, and (b) the requirement of geologic-seismic reports for building permits not requiring grading of the land, and (2) local governments to create grading ordinances prohibiting construction over active faults.

Justification

Particular ramifications involving zoning and grading regulations become evident upon reflection on their relationships. While grading regulations certainly entail geologic-soils parameters not necessarily encountered at the early stage of land development and use, a case can be made for the interplay of geology and soils between both the zoning stage and the grading phase. For example, the potential for unsolvable geologic-seismic and soils problems should be resolved during the land-use planning or zoning stage, whereas the grading regulation involving all three earth science disciplines (geology, seismology, and soils) can readily produce a useful land development which otherwise might lie fallow for years to come. Therefore, some division of fault line restrictions between zoning and building regulations should be made, with building codes covering certain specifications for earth science analysis and zoning ordinances governing permitted uses and occupancies in areas not subject to correction, such as the location of active fault zones and specific fault traces. State support regulating grading and construction with respect to active fault zones, seismicity, and other geologic hazards as well, is needed.

3. *Review Capabilities*

The implementation of local ordinances governing geologic-seismic control over grading operations is urgently needed now, and should be accomplished under the aegis of state standards and requirements. Only limited state review is warranted, however, for the sake of efficiency of time spent processing permits for construction and/or grading.

Sufficient latitude must be allowed the local government to create geological departments independent from other professional group pressures. The department could even consist of one man advising the City Manager, the City Council, or the County Board of Supervisors through a Chief Administrative Office. In this capacity, private consultant firms could also act as advisors, as well as the Division of Mines and Geology under a service contract.

Building or grading permit fees could be charged the developer sufficient in amount to defray the cost of review borne by the local agency, or by the Division of Mines on behalf of the agency.

The reader is referred to Section VI, Geotechnical Assistance for Local Governments, of this report for a detailed analysis of review capabilities.

Recommendation

Introduce State Legislation requiring jurisdictions to adopt a regulation that all building and grading permits be reviewed by an independent, competent geological staff to determine if a geologic or soils report is needed and, if so, if he determines it is adequate.

Justification for Above Recommendations

Local governments reviewing the potential for apparent active faults could more effectively prohibit construction over faults by creating geological departments answerable to a City Council or a Board of Supervisors, and not to another professional group as a Department of Engineering. Zoning and grading regulations could then be more effectively free from coercive antagonisms brought about by placing professional geologists under an engineering department having supervisorial powers. Proper zoning decisions

for the planning agency would then be free from Building and Safety Department influence except where its involvement would be appropriate. Thus, the proper stress for geological input by geologists would be met.

III. Land-Use Planning -- Fault Hazard Control

A. State Control along Active Faults

Introduction

On January 3, 1973 Governor Reagan signed into law the Alquist-Priolo Geologic Hazard Zones Act (Senate Bill 520). It was of the utmost urgency that the Legislature mandate land-use regulations throughout the State in areas of apparent active faulting in such detail as to insure equitable application of controls.

The intent of the Act is to require cities and counties to exercise specified approval authority with respect to real estate developments or structures for human occupancy within delineated special studies zones encompassing areas of earthquake hazard. These earthquake hazards consist of potentially and recently active traces of specifically known fault zones, or such other faults as the State Geologist deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep.

If an undue hazard were to be created, approval may be withheld pending geologic and engineering studies to more adequately define the zone of hazard. No studies can be waived without the approval of the State Geologist.

Though the Act is a step in the right direction, it does not appear to include other geologic hazards resulting from the effects of seismic shaking within special studies zones, such as soil liquefaction potential, reactivation of existing landslides and the potential creation of new landslides, ground rupture, settlement, etc.

Legislation to further implement the goals of the Joint Committee on Seismic Safety should contain the following amendments to S.B. 520:

1. Definition of (a) active fault trace, and (b) active fault zone as in A.B. 407 introduced in the 1972 Legislature.

2. Specific prohibition of structure for public service facilities (highways, dams, bridges, utilities, etc.) on an active fault trace or where an undue hazard would be created except where it shall be deemed essential to do so for the public welfare. S.B. 520 only designates "Special Studies Zones."

3. Require that all actions to zone land for single-family residences or public service facilities anywhere within an active fault zone be reviewed and approved by appropriate agencies of local or regional governments, pending the submittal of geologic-seismic reports evaluating the potential for active fault traces or major geologic hazards.

4. Require that approval of building permits for subdivisions or lot revision for single-family residences within the Special Studies Zones, by the local Planning Commission, City Council, or County Board of Supervisors be contingent upon:

(a) The submittal of geologic and engineering reports. (In accordance with S.B. 520, approval of development may be withheld pending submittal of geologic/engineering reports for review.)

(b) The review of geologic and engineering reports by a qualified geologic and engineering staff. These reports must be directed to the problem of surface faulting and other geologic hazards caused by seismic shaking.

(c) The determination that an undue geologic hazard would not result from the zoning, subdivision of lands, or construction, and

(d) The determination that the proposal is consistent with the Seismic Safety Element and other provisions of the General Plan and its implementing zoning ordinances, if any, as well as statements contained in any Environmental Impact Reports.

5. Require approval for all repairs or reconstruction of existing structures and facilities, as defined in (8) and (9) that, in any one year, exceeds 20% of the market value of the structure or facility.

6. Provide for State geologic and planning guidance and technical assistance to local governments through a State Seismic Safety Commission having regional components, or if a Commission is not established, through the Office of Planning and Research. The intent of this

proposed amendment is to supersede the State Mining and Geology Board's function and provide a broader base for research and consultation.

7. Require that all capital improvement projects proposed by state and local governments be subject to the same review and approval procedures required of private developers.

Analysis and Implementation

An ultimate goal of S.B. 520 was to provide minimal policies and criteria to assist cities, counties and state agencies in the exercise of their responsibility to provide for public safety in hazardous fault zones.

Loss of life and property from earthquakes results when man's activities occur in areas affected by earthquake processes--faulting, shaking, ground failure, water waves, and land level changes. The most easily identifiable of these processes is the location, scope, and type of surface rupture from active faulting; therefore, life and property losses from this process are relatively controllable with adequate thought and action by society. Thus far, however, only one jurisdiction in California has adopted a minimal type ordinance restricting development on active fault traces, although several jurisdictions have such action pending. Should the Geologic Hazard Zones Act be amended to include the above recommendations, local agencies would be gaining needed state support for implementing proper controlling ordinances covering all geologic hazards within designated fault zones.

B. Federal Projects and Construction

Introduction

Recommendations made under State Control of Active Faults may have little direct effect on federal installations within the "Special Studies Zones" of the Geologic Hazard Zones Act. The Federal Government should be made cognizant of the State's and the local agencies' requirements at the earliest stage possible. Preferably, this would be at the zoning phase of proposed land use development.

(a) Recommendation -- Petition the U.S. Congress to require that all Federal projects within active fault zones ("Special Studies Zones") be submitted for review and approval by the local agencies during the initial planning phase to determine:

1. Does the project conform with the local planning agencies' zoning ordinances required by State Law in its General Plan?

2. Does the project conform to the Environmental Impact Statement requirement?

(b) Analysis and Implementation -- Under existing law and practice, local governments could define an area and buildings within hazardous areas, could make findings, and could restrict construction, and remove and/or reconstruct buildings in the area. It would be necessary, under present procedure, to make a finding under the "Workable Program Feature" that designated areas are hazardous. The local government (city-county) would zone the areas as restricted and as areas calling for redevelopment in its plan and program. In case of disaster, the community could then use Federal removal and redevelopment programs to rationalize land uses. There is no question about the use of this program for clearance and other uses in seismic areas.

(c) Adoption of Ordinances by Local Governments

Recommendation

State legislation should be introduced requiring local governmental agencies to enact an ordinance prohibiting construction over an apparent active fault.

Implementation and Justification

Though the purpose of the Geologic Hazard Zones Act is to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties, as well as to implement such general plan as may be in effect in any city or county, the new law does not appear to make mandatory the adoption of such ordinances and laws. An example of such an ordinance may be patterned after Los Angeles County's former "Earthquake Fault Ordinance-Section 310, July 17, 1970,"

a modified version of which is suggested below:

Suggested Earthquake Fault Ordinance

Earthquake Faults. If a building site is within an apparent active fault zone, and the (City-County) Engineer so finds, geological or engineering reports submitted in connection with the evaluation of such a site shall contain information pertaining to the safety of such building site with respect to the probability of surface fractures occurring during an earthquake within the fault zone. Such reports shall also contain a recommendation as to the magnitude of ground shaking to be assumed in determining the aseismic design of the building.

The (City-County) Engineer shall maintain maps showing the location of apparent active fault traces within active fault zones when such faults have been accurately located by geologic investigation, and such information has been filed with the (City-County) Engineer.

Buildings shall not be constructed over these potentially active faults.

Exception: Light-frame buildings not over one story or twelve feet in height, having an area of not more than one thousand square feet and not used for human occupancy, may be constructed over such a fault.

Buildings within a potentially active fault zone shall be designed to resist the earthquake forces prescribed by this code, or those recommended in the geological or engineering reports, whichever is greater.

Ordinance No. 10037 of Los Angeles County is appended under the Building and Grading Regulations section of this report.

Ordinance No. 10,037

An ordinance adding Section 310 to Ordinance No.2225, the Building Code, relating to building sites within potentially active earthquake fault zones.

The Board of Supervisors of the County of Los Angeles do ordain as follows:

Section 1. Section 310 is added to Ordinance No. 225 entitled, "Building Code," adopted March 20, 1933, to read:

SEC. 310. EARTHQUAKE FAULTS.

If a building site is within a potentially active fault zone, and the County Engineer so finds, geological or engineering records submitted in connection with the evaluation of such site shall contain information pertaining to the safety of such building site with respect to the probabilty of surface fractures occurring during an earthquake on the fault zone. Such reports also shall contain a recommendation as to the magnitude of ground shaking to be assumed in determining the aseismic design of the building.

For the purposes of this section, potentially active earthquake faults shall be those within the San Andreas Fault zone which enters the county at a point southeasterly from Big Pines and extends across the county in a northwesterly direction leaving the county near the intersection of the boundaries of the Counties of Kern, Los Angeles, and Ventura; and the Newport-Inglewood Fault zone which extends in a generally northwesterly direction through the cities of Long Beach and Signal Hill, and traversing the Baldwin Hills to the north.

The County Engineer shall maintain maps showing the location of faults within potentially active fault zones when such faults have been accurately located by geologic investigation, and such information has been filed with the County Engineer.

Buildings shall not be constructed over a potentially active fault.

Exception:

Light-frame buildings not over one (1) story or twelve (12) feet in height, having an area of not more than one thousand (1000) square feet and not used for human occupancy, may be constructed over such a fault when an agreement has been recorded in the office of the County Recorder relieving the county, its officers and employees of liability for damage or loss which may result from the construction or use of such building. The agreement shall be binding on successors of interest in such property.

Buildings within a potentially active fault zone shall be designed to resist the earthquake forces prescribed by this code or those recommended in the geological or engineering reports, whichever is greater.

Section 2. This ordinance shall be published in the Journal of Commerce and Independent Review, a newspaper printed and published in the County of Los Angeles.

(Seal) *ERNEST E. DEBS,*
ATTEST: *Chairman.*

JAMES S. MIZE,
Executive Officer - Clerk of the Board of Supervisors of the County of Los Angeles.

I hereby certify that at its meeting of June 16, 1970, the foregoing ordinance was adopted by the Board of Supervisors of said County of Los Angeles by the following vote, to wit:

Ayes: Supervisors Frank G. Bonelli, Kenneth Hahn and Burton W. Chace.

Noes: None.

(Seal) *JAMES S. MIZE,*
Executive Officer - Clerk of the Board of Supervisors of the County of Los Angeles.

Effective Date July 17, 1970.
(88174) June 26

LEGISLATION PERTAINING TO SCHOOLS

SENATE BILL 689

School Building Sites

An Act to amend Section 15002.1 of the Education Code, relating to school sites.

SB 689, Alquist. School building sites.

Makes clarifying changes in provision requiring geological and engineering investigations of school sites.

Revises causes of possible earthquake damage to which specified engineering studies must be directed.

The people of the State of California do enact as follows:

SECTION 1. Section 15002.1 of the Education Code is amended to read:

15002.1. The governing board of a school district, prior to acquiring any site on which it proposes to construct any school building as defined in Section 15452 shall have the site, or sites, under consideration investigated by competent personnel to ensure that the final site selection is determined by an evaluation of all factors affecting the public interest and is not limited to selection on the basis of raw land cost only. The investigation shall include such geologicl and soil engineering studies by competent personnel as are needed to provide an assessment of the nature of the site and potential for earthquake damage.

The geological and soil engineering studies of the site shall be of such a nature as will preclude siting of a school in any location where the geological characteristics are such that the construction effort required to make the site safe for occupancy is economically unfeasible. The evaluation shall also include location of the site with respect to population, transportation, water supply, waste disposal facilities, utilities, traffic hazards, surface drainage conditions, and other factors affecting the operating costs, as well as the initial costs, of the total project.

No school building shall be constructed or situated on the trace of an active geological fault. For purposes of this section, an active geological fault is defined as one along which surface rupture can be reasonably expected to occur within the life of the building.

Similar geological and soil engineering investigations shall be made as deemed necessary by the Department of General Services for the construction of any school building as defined in Section 15452 or, if the estimated cost exceeds ten thousand dollars ($10,000), the reconstruction or alteration of or addition to any such school building for work which alters structural elements. No such study need be made if the site or sites under consideration have been the subject of adequate prior study.

A copy of the report of each investigation conducted pursuant to this section shall be submitted to the Department of General Services and the Department of Education pursuant to Article 4 (commencing with Section 15451) of Chapter 2 of this division. The cost of geological and soil engineering studies and investigations conducted pursuant to this section may be treated as a capital expenditure.

LEGISLATION PERTAINING TO HOSPITALS

SENATE BILL 519

Hospital Construction - Signed by Governor, December 1972

An act to add Division 12.5 (commencing with Section 15000) to the Health and Safety Code, relating to hospitals, and making an appropriation therefor.

Legislative Counsel's Digest

SB 519, as amended, Alquist. Hospital construction.

Requires the State Department of Public Health, through a contract with the Department of General Services, to (1) observe the construction of or addition to any hospital building or, if the work alters structural elements, the reconstruction or alteration of any hospital building, as

it deems necessary for the protection of life and property; and (2) pass upon and approve or reject all plans for the construction or the alteration of any hospital building, independently reviewing the design and geological data to assure compliance with the requirements of the act. Requires that geological data be reviewed by an engineering geologist and structural design data be reviewed by a structural engineer.

Requires the governing board of each hospital or other hospital governing authority, before adopting any plans for such hospital building, to submit the plans to the State Department of Public Health for approval and to pay prescribed fees, specifies what must accompany the application for approval, and prescribes requirements for plans and specifications.

Creates a Hospital Building Account in the Architecture Public Building Fund, requires that all fees collected pursuant to the act be credited to such account, and continuously appropriate money in such account, without regard to fiscal years, for the use of the State Department of Public Health, subject to approval of the Department of Finance, in carrying out the provisions of the act.

Declares that no contract for the construction or alteration of any hospital building made or executed on or after the effective date of the act is valid, and prohibits payment of any money for work done under such a contract, or for any labor or materials furnished in constructing or altering any such building, unless prescribed requirements are satisfied.

Prescribes requirements re administration of the work of construction, inspection of hospital buildings and of the work of construction or alteration, and reports concerning the work of construction or alteration.

Authorizes the State Department of Public Health to call upon the Department of General Services to make a periodic review of hospital operations to assure that the hospital is adequately prepared to resist damage caused by earthquake tremor and prescribes requirements re such review.

Authorizes the State Department of Public Health to make regulations to carry out the act.

Requires the Director of Public Health to appoint a Building Safety Board to advise and act as a board of appeals in all matters affecting seismic safety in the administration and enforcement of the act.

Exempts an architect or structural engineer from personal liability for personal injury or property damage resulting from structural inadequacy or failure of hospital building, if such person exercised normal professional diligence in carrying out his functions under the act.

Declares intent of the Legislature to preempt from local jurisdictions the enforcement of building regulations adopted pursuant to this act, including plan checking, and intent of the Legislature that where local jurisdictions have more restrictive standards for enforcement of building regulations and construction supervision, such standards shall be enforced by the state.

Prescribes penalty for violations.

Defines "hospital building," "construction or alteration," "architect," "structural engineer," and "engineer geologist."

The people of the State of California do enact as follows:

SECTION 1. The Legislature finds and declares as follows:

(a) California is situated on the rim of the great Circum-Pacific seismic belt and it is inevitable that strong seismic disturbances along this belt will cause extensive property damage and endanger the lives of all people who enter or are near buildings which may collapse or be seriously damaged by such seismic disturbances.

(b) It is reasonable to expect that any building located anywhere within California will be subjected to the forces generated by a strong earthquake at least once during its life.

(c) Following the 1933 Long Beach earthquake, the Legislature enacted the so-called "Field Act" (Sections 15451 to 15466, inclusive, Education Code) as an urgency measure, which established reasonable minimum standards and procedures for the design and construction of new public school buildings. The durability during subsequent earthquakes of school buildings designed and constructed under the provisions

of those statutes, when compared with the durability during the same earthquakes of other buildings not designed and constructed pursuant to the "Field Act," has repeatedly illustrated the prudence of such legislation.

(d) The San Fernando Valley earthquake of February 9, 1971, although moderate in terms of total energy release, resulted in such total collapse or damage as made many hospital buildings inoperable. Some of these damaged or destroyed hospital buildings were relatively new structures, designed and constructed to meet the standards as prescribed by most local jurisdictions throughout the State of California.

SEC. 2. It is the intent of the Legislature that hospitals, which house patients having less than the capacity of normally healthy persons to protect themselves, and which must be completely functional to perform all necessary services to the public after a disaster, shall be designed and constructed to resist, insofar as practicable, the forces generated by earthquakes, gravity, and winds. In order to accomplish this purpose the Legislature intends to establish proper building standards for earthquake resistance based upon current knowledge, and intends that procedures for the design and construction of hospitals be subjected to independent review. It is further the intent of the Legislature that Division 12.5 (commencing with Section 15000) of the Health and Safety Code shall be administered by the State Department of Public Health, which shall contract for enforcement of such provisions with the Department of General Services which now successfully enforces the provisions of the "Field Act."

SEC. 3. Division 12.5 (commencing with Section 15000) is added to the Health and Safety Code, to read:

DIVISION 12.5. BUILDINGS USED BY THE PUBLIC

CHAPTER 1. Hospitals

15000. It is the intent of the Legislature that the Department of General Services shall analyze the structural systems and details, as set forth in the working drawings and specifications, and inspect the construction of hospital projects and report the findings of such analysis to the state department. It is further the intent of the Legislature to preempt from local jurisdictions the enforcement of building regulations adopted pursuant to this chapter including the plan checking. It is further the intent of the Legislature that where local jurisdictions have more restrictive standards for the enforcement of building regulations and construction supervision, such standards shall be enforced by the state.

15001. "Hospital building," as used in this chapter, means and includes any building used, or designed to be used, for a hospital and shall include all of the following:

(a) All hospitals of a type required to be licensed pursuant to Chapter 2 (commencing with Section 1400) of Division 2 and facilities of a type required to be licensed pursuant to Chapter 1 (commencing with Section 7000) of Division 7 of the Welfare and Institutions Code.

(b) Institutions conducted, maintained, or operated by this state or any state department, authority, district, bureau, commission, or officer or by the Regents of the University of California, or by a board of supervisors of a county under the provisions of Chapter 2.5 (commencing with Section 1440) of Division 2, which, except for the exemption provided by Section 1415, would be encompassed by the terms of subdivision (a).

15002. "Construction or alteration," as used in this chapter, includes any construction, reconstruction, or alteration of, or addition to, any hospital building.

15003. "Architect," as used in this chapter, means a person who is certified and holds a valid license under Chapter 3 (commencing with Section 5500) of Division 3 of the Business and Professions Code.

15004. "Structural engineer," as used in this chapter, means a

person who is validly certified to use the title structural engineer under Chapter 7 (commencing with Section 6700) of Division 3 of the Business and Professions Code.

15005. "Engineering geologist," as used in this chapter, means a person who is validly certified under Chapter 12.5 (commencing with Section 7800) of Division 3 of the Business and Professions Code.

15006. The state department, through its contract with the Department of General Services, shall observe the construction of, or addition to, any hospital building or, if the work alters structural elements, the reconstruction or alteration of any hospital building, as it deems necessary to comply with the provisions of this chapter for the protection of life and property.

15007. The state department, through its contract with the Department of General Services, shall pass upon and approve or reject all plans for the construction or the alteration of any hospital building, independently reviewing the design and geological data to assure compliance with requirements of this chapter. Geological data shall be reviewed by an engineering geologist and structural design data shall be reviewed by a structural engineer. The governing board of each hospital or other hospital governing authority, before adopting any plans for such hospital building, shall submit the plans to the state department for approval and shall pay the fees prescribed in this chapter.

15008. In each case, the application for approval of the plans shall be accompanied by the plans and full, complete, and accurate specifications, and structural design computations, and the specified fee, which shall comply with requirements prescribed by the state department.

15009. Plans submitted pursuant to this chapter for work which affects structural elements shall contain an assessment of the nature of the site and potential for earthquake damage, based upon geologic and engineering investigations by competent personnel of the causes of earthquake damage. One-story Type V construction of 4,000 square feet or less shall be exempt from the provisions of this section.

15010. The engineering investigation shall be correlated with

the geologic evaluation made pursuant to Section 15009.

15011. The application shall be accompanied by a filing fee in an amount which the state department determines will cover the costs of administering this chapter. Such fee shall be based on a uniform percentage of the estimated construction cost, and shall not exceed 0.7 percent of the estimated construction cost.

The minimum fee in any case shall be one hundred dollars ($100). If the actual construction cost exceeds the estimated construction cost by more than 5 percent, a further fee shall be paid to the state department, based on the above schedule and computed on the amount by which the actual cost exceeds the amount of the estimated cost.

15012. All fees shall be paid into the State Treasury and credited to the Hospital Building Account, which is hereby created in the Architecture Public Building Fund, and are continuously appropriated without regard to fiscal years for the use of the state department, subject to approval of the department of Finance, in carrying out the provisions of this chapter. Adjustments in the amounts of the fees, as determined by the state department and approved by the Department of Finance, shall be made within the limits set in Section 15011 in order to maintain a reasonable working balance in the account.

15013. All plans and specifications shall be prepared by an architect. A structural engineer shall prepare the structural design for such plans and specifications. Administration of the work of construction shall be under the responsible charge of such architect and structural engineer, except that where plans and specifications for alterations or repairs do not affect architectural or structural conditions, such plans and specifications may be prepared and work of construction may be administered by a professional engineer duly qualified to perform such services and holding a valid certificate under Chapter 7 (commencing with Section 6700) of Division 3 of the Business and Professions Code for performance of services in that branch of engineering in which said plans, specifications, and estimates and work of construction are applicable.

15014. Before letting any contract for any construction or alteration of any hospital building, the written approval of the plans as to safety of design and construction, by the state department,

through its contract with the Department of General Services, shall be first had and obtained.

15015. No contract for the construction or alteration of any hospital building, made or executed on or after the effective date of this chapter by the governing board or authority of any hospital or other similar public board, body, or officer otherwise vested with authority to make or execute such a contract, is valid, and no money shall be paid for any work done under such a contract or for any labor or materials furnished in constructing or altering any such building, (1) unless the plans and specifications comply with the provisions of this chapter and the requirements prescribed by the state department, and (2) the approval thereof in writing has first been had and obtained from the state department, through its contract with the Department of General Services, and (3) the hospital building is to be accessible to, and usable by, the physically handicapped, and (4) the plans and specifications comply with the first and panic safety requirements of the State Fire Marshal.

15016. The state department, through its contract with the Department of General Services, shall make such inspection of the hospital buildings and of the work of construction or alteration as in its judgment is necessary or proper for the enforcement of this chapter and the protection of the safety of the public. The hospital governing board or authority shall provide for and require competent, adequate, and continuous inspection during construction or alteration by an inspector satisfactory to the architect, structural engineer, and the state department. The inspector shall act under the direction of the architect and structural engineer, and be responsible to the board or authority. Notwithstanding any other provision of this section, where alterations or repairs are to be conducted under the supervision of a professional engineer pursuant to Section 15013, the inspector need only be satisfactory to the state department and to the professional engineer, and the inspector shall act under the direction of the professional engineer. In approving any inspector, the state department shall consult with the Department of General

Services.

15017. From time to time, as the work of construction or alteration progresses and whenever the Department of General Services requires, the architect and structural engineer in charge of construction or registered engineer in charge of other work, the inspector on the work, and the contractor shall each make to the Department of General Services a report, duly verified by him, upon a form prescribed by the state department, in consultation with the Department of General Services, showing, of his own personal knowledge, that the work during the period covered by the report has been performed and materials used and installed are in accordance with the approved plans and specifications, setting forth such detailed statements of fact as are required by the Department of General Services.

The term "personal knowledge," as used in this section and as applied to the architect and registered engineer, means personal knowledge which is the result of such general administration of construction as is required and accepted of, and for, such persons in the construction of buildings. Such persons shall, however, use reasonable diligence to obtain the information required.

The term "personal knowledge," as applied to the inspector, means the actual personal knowledge of the inspector obtained by his personal, continuous observation of the work of construction at the construction site in all stages of progress.

15018. Upon written request to the state department by the governing board or authority of any hospital, the state department through contract with the Department of General Services shall make, or cause to be made, an examination and report on the structural condition of any hospital building subject to the payment by the governing board or authority of the actual expenses incurred by the state department.

15019. The state department may call upon the Department of General Services to make a periodic review of hospital operation to assure that the hospital is adequately prepared to resist damage caused by earthquake tremor. The review shall include, but not be limited to, evaluations of the structural safety of elevators,

standby equipment and emergency procedures, and procedures and facilities for storage of dangerous gases, liquids, and solids. The governing board or authority of the hospital shall reimburse the state department for actual expenses incurred in making such review. The state department shall contract with the Department of General Services for such services.

15020. The state department, with the advice of the Department of General Services, shall from time to time make such rules and regulations as it deems necessary, proper, or suitable to effectually carry out the provisions of this chapter.

15021. There is in the state department a Building Safety Board which shall advise and act as a board of appeals with regard to seismic structural safety of hospitals. The Director of Public Health, with the advise of the Department of General Services, shall appoint the members of the Building Safety Board, which shall advise and act as a board of appeals in all matters affecting seismic structural safety in the administration and enforcement of this chapter. The board shall consist of 11 members appointed by the Director of Public Health and six ex officio members who are: the Director of Public Health, the State Architect, the State Fire Marshal, the State Geologist, the Chief of the Bureau of Health Facilities Planning and Construction in the state department and the Chief Structural Engineer of the Schoolhouse Section of the Office of Architecture and Construction in the Department of General Services. Of the appointive members, two shall be structural engineers, two shall be architects, one shall be an engineering geologist, one shall be a soils engineer, one shall be a seismologist, one shall be a mechanical engineer, one shall be an electrical engineer, and one shall be a hospital administrator. The appointive members shall serve at the pleasure of the director. He may also appoint as many other ex officio members as he may desire. Ex officio members are not entitled to vote. Board members, qualified by close connection with hospital design and construction and highly knowledgeable in their respective fields with particular reference to seismic safety, shall be appointed from nominees recommended by the governing bodies of the Structural Engineers Association of California; the California Council, American Institute of Architects; the

the Earthquake Engineering Research Institute; the Association of Engineering Geologists; the Consulting Engineers Association of California; the California Hospital Association. Board members shall be residents of California.

15022. The Building Safety Board shall convene upon request of the chairman thereof. He may convene a meeting of the board whenever it may be necessary, in his judgment, for the board to meet. The board shall adopt such rules of procedure as are necessary to enable it to perform its duties. The chairman of the board shall, in his discretion, or upon instructions from the board, designate subcommittees to study and report back to the board upon any technical subject or matter for which an independent review or further study is desired. Members of the board shall be reimbursed from the Hospital Building Account in the Architecture Public Building Fund for their reasonable actual expenses in attending meetings conducted to carry out the provisions of this chapter, but shall receive no compensation for their services.

15023. No licensed architect or licensed structural engineer, employed by the governing board or authority of a hospital to prepare plans for any hospital-building construction or alteration or employed to examine any hospital building pursuant to this chapter, shall be held personally liable for injury to persons or damage to property resulting from structural inadequacy or failure of the hospital building, provided such architect or engineer has exercised normal professional diligence in carrying out his functions under this chapter.

15024. Any person who violates any provision of this chapter is guilty of a misdemeanor.

LEGISLATION PERTAINING TO DAMS AND HIGHWAYS

SENATE BILL 896

Seismic Safety of Dams

An act to add Section 8589.5 to the Government Code, relating to seismic safety.

SB 896, as introduced, Alquist. Seismic safety.

Requires Office of Emergency Services to encourage emergency procedures for evacuation and control of populated areas below dams. Requires office to make specified determinations. Requires designated local agencies to develop evacuation plans. Requires inundation maps. Requires report to Legislature.

The people of the State of California do enact as follows:

SECTION 1. The Legislature intends, by this act, to encourage procedures for the emergency evacuation and control of populated areas below dams. The value of such a program has been demonstrated by that of the Los Angeles Department of Water and Power, administered by the Los Angeles Police Department, which has been very successful.

SEC. 2. Section 8589.5 is added to the Government Code, to read:

8589.5. (a) The Office of Emergency Services shall encourage local governmental organizations, utilities, and owners of dams to adopt emergency procedures for the evacuation and control of populated areas below dams. The office shall determine whether adequate public safety measures exist for the evacuation and control of populated areas below dams the partial or complete failure of which would be likely to result in death, injury and property damage.

(b) Inundation maps showing the potential flood zones based on the maximum legal capacity of the particular dam shall be prepared by the owner of each dam specified by the Office of Emergency Services. The delivery of such maps in complete form to the governing bodies of the jurisdictions likely to be affected shall be accomplished

within six months from the effective date of this section. Copies of such maps shall be reviewed, approved, and filed with the Department of Water Resources and the Office of Emergency Services.

(c) The appropriate governmental agency designated by the Office of Emergency Services shall develop evacuation plans. Such plans shall include, at least: (1) delineation of area to be evacuated; (2) routes to be used; (3) traffic control measures; (4) shelters to be activated for the care of the evacuees; (5) methods for the movement of people without their own transportation; (6) identification of particular areas of facilities in the flood zones which will not require evacuation because of their location on high ground or similar circumstances; (7) identification and development of special procedures for the evacuation and care of people from unique institutions; (8) procedures for the perimeter and interior security of the area, including such things as passes, identification requirements, and antilooting patrols; (9) procedures for the lifting of the evacuation and reentry of the area; and (10) details of which organizations are responsible for these functions and the material and personnel resources required. The agency that prepares such a plan shall review it at least every two years.

SEC. 3. The Office of Emergency Services shall report to the Legislature on the plans required by this act within 21 months of its enactment.

ASSEMBLY BILL 1611

Highway Construction

An act relating to uncompleted state highway facilities damaged by earthquake, and declaring the urgency thereof, to take effect immediately.

AB 1611, as introduced, Lewis (Trans.). State highway construction contracts.

New act.

States legislative findings re damage to state highway construction in the vicinity of the City of San Fernando caused by the earthquake of February 9, 1971.

Requires the Department of Public Works to conduct thorough investigation of the geologic characteristics of construction zone, and prohibits permanent reconstruction until investigation is completed.

Authorizes the department to terminate any construction contracts upon mutual consent of the contracting parties, if work under such contracts was substantially damaged or destroyed by the earthquake. Specifies principles to be followed by the department in seeking agreement to terminate such contracts.

To take effect immediately, urgency statute.

The people of the State of California do enact as follows:

SECTION 1. The Legislature finds and declares as follows:

(a) Extensive earthquake damage to state highway facilities under construction in the vicinity of the City of San Fernando has created a severe obstacle to public traffic and a continuing danger to the public welfare.

(b) The sudden earthquake action in a zone heretofore considered to be inactive requires that thorough geologic investigations be made to determine the feasibility of reconstructing the damaged work, and to determine the proper placement and construction of the highway facilities.

(c) Due to the great magnitude of observable damage, the indeterminate magnitude of concealed and subsurface damage, and the length of time which will be required for the completion of necessary investigations, the public interest and public safety would be adversely affected by an immediate attempt to resume construction.

SEC. 2. The Department of Public Works shall perform a thorough investigation of the geologic characteristics of the construction zone to ascertain the probable influence which the proximity of the earthquake fault will have upon the construction of highway facilities. Permanent reconstruction shall not be resumed before such investigation

is completed.

SEC. 3. In order to prevent the performance of further construction before the completion of the necessary investigations into the sufficiency and safety of such construction, the Department of Public Works is authorized to terminate any contract for state highway construction in the vicinity of the City of San Fernando, if the work of such contract was substantially damaged or destroyed by earthquake; provided, that such termination shall be by the mutual consent of the contracting parties. Such termination shall be deemed to constitute completion of the work.

SEC. 4. The terms and conditions under which such contracts may be terminated shall be agreed upon by the contracting parties. However, it is the intent of the Legislature that the Department of Public Works be guided by the following principles in seeking to reach agreement respecting termination:

(a) The compensation received by a contractor for all work performed prior to the earthquake shall be the reasonable cost of the performance of such work as it can be reasonably ascertained without the inclusion of a profit; provided, that such cost shall not be in excess of the contract price of such work. The determination of the contract price of partially completed items of work shall be determined by apportioning such contract prices.

(b) Such termination shall not preclude payment to the contractor for work performed after the earthquake for which he would have been entitled to payment but for such termination.

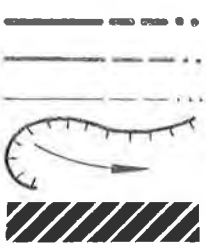
(c) That the agreement of termination shall operate as a complete and final resolution of the rights of the respective parties, and as a bar to any further claims or demands between them; provided, that this shall not affect the rights of third parties who are subrogated to the rights of the contractor.

SEC. 5. This act is an urgency statute necessary for the immediate preservation of the public peace, health or safety within the meaning of Article IV of the Constitution and shall go into immediate effect. The facts constituting such necessity are:

Various highway facilities were destroyed, or rendered unsafe and unusable, by the earthquake of February 9, 1971. Contracts are presently in effect which call for the performance of further construction in the area of greatest damage. Such contracts must either be performed or they must be terminated. It would be contrary to the public interest to continue to perform such contracts before the full extent of subsurface damage has been ascertained, or before a full investigation has been made into the geologic instability of the area, the risk of further earthquakes, and the type of construction which may be required to resist such earthquakes. The Legislature has determined that the public interest would be best served by an immediate termination of such contracts, but there is not administrative procedure presently in effect pursuant to which such termination may be accomplished.

Therefore, it is necessary that this act go into immediate effect.

MAP LEGEND



CLASS I - Prominent or Obvious Fault

CLASS II - Probable Fault or Rupture

CLASS III - Probable Fault or Rupture

LANDSLIDE - Arrow shows direction of movement

Limits of Present Investigation

NOTE: DASHED LINES are approximate.
DOTTED LINES are concealed or inferred.

All lineaments have been mapped using special low sun-angle aerial photography taken especially for this project. The basic scale of the photographs is 1:12,000, or 1 inch represents 1,000 feet. Fault-related features have been transferred from photographs to topographic base maps using a vertical sketchmaster and were checked by inspection and scale dividers.

We are confident that the features plotted as Class I faults are the locations of the most recent surface fault ruptures. The Class I features commonly have significant vertical relief or extend from surface ruptures having significant vertical relief. For the present study, very fresh fissures related to earthquake shaking are also mapped as Class I.

It is our belief that all the Class I lineaments are well defined topographic features that mark the most recent surface fault ruptures. They are believed to have been mostly produced by, or related to, rapid fault displacements associated with strong earthquakes. Most Class I ruptures are undoubtedly the result of repeated fault displacements that are concentrated along previously established planes of weakness. Therefore, the Class I faults are the most likely candidates for significant future development. Some surface fault offset along the Wasatch fault may be due to slow tectonic creep, as has been documented along other active faults. This problem should be considered in further evaluations.

The Class II features are probable surface faults or obvious surface faults showing much older activity. Most of the Class II features show little vertical relief and may be secondary fault-related features associated with ground failure or graben development.

The Class III features are possible surface faults. They have little or no vertical relief. Most of them appear to be related to the Class I and II fault features; however, some Class III features may represent erosional fault-line features or shoreline features; this should be taken into consideration during more detailed investigations. The Class III features are shown because we feel they are possibly fault-related and are important enough to be considered for further investigation and evaluation. Our confidence level decreases from Class I to III.

It is important to understand that some minor fault breaks may not have been identified or recognized as they may be easily confused with other topographic features, such as shorelines. Again, this emphasizes the need for more detailed surface mapping and subsurface investigations.

Landslides are common along portions of the Wasatch fault. Many of them are outlined on the prepared maps. Some are presently active and some appear to be in a state of equilibrium. The landslide debris deposits are important because, even though some appear not to be presently moving, they are potentially unstable, especially if they are altered or disturbed. Disturbances by earthquakes, fault movements, man-made cuts or heavy rainfall could re-activate the slide mass. Therefore, detailed investigations must be carried out before development is allowed near these landslides.

ACCURACY

Fault-related features plotted on the map generally have a lateral accuracy of ±100 feet. In areas of high relief or where cultural development such as roads, fence lines, and other similar features are lacking, the accuracy may be not better than ±200 feet. In urbanized areas, the fault features have been modified and obscured by urban development, and only the most obvious scarps are plotted; more detailed studies are needed to locate the less prominent secondary faults.

PURPOSE OF MAPS

The purpose of these maps is to aid general regional land-use planning. The information presented is intended to provide a framework for more detailed investigations and evaluations.

West Facing Scarps

Subtle Breaks in Slope

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY

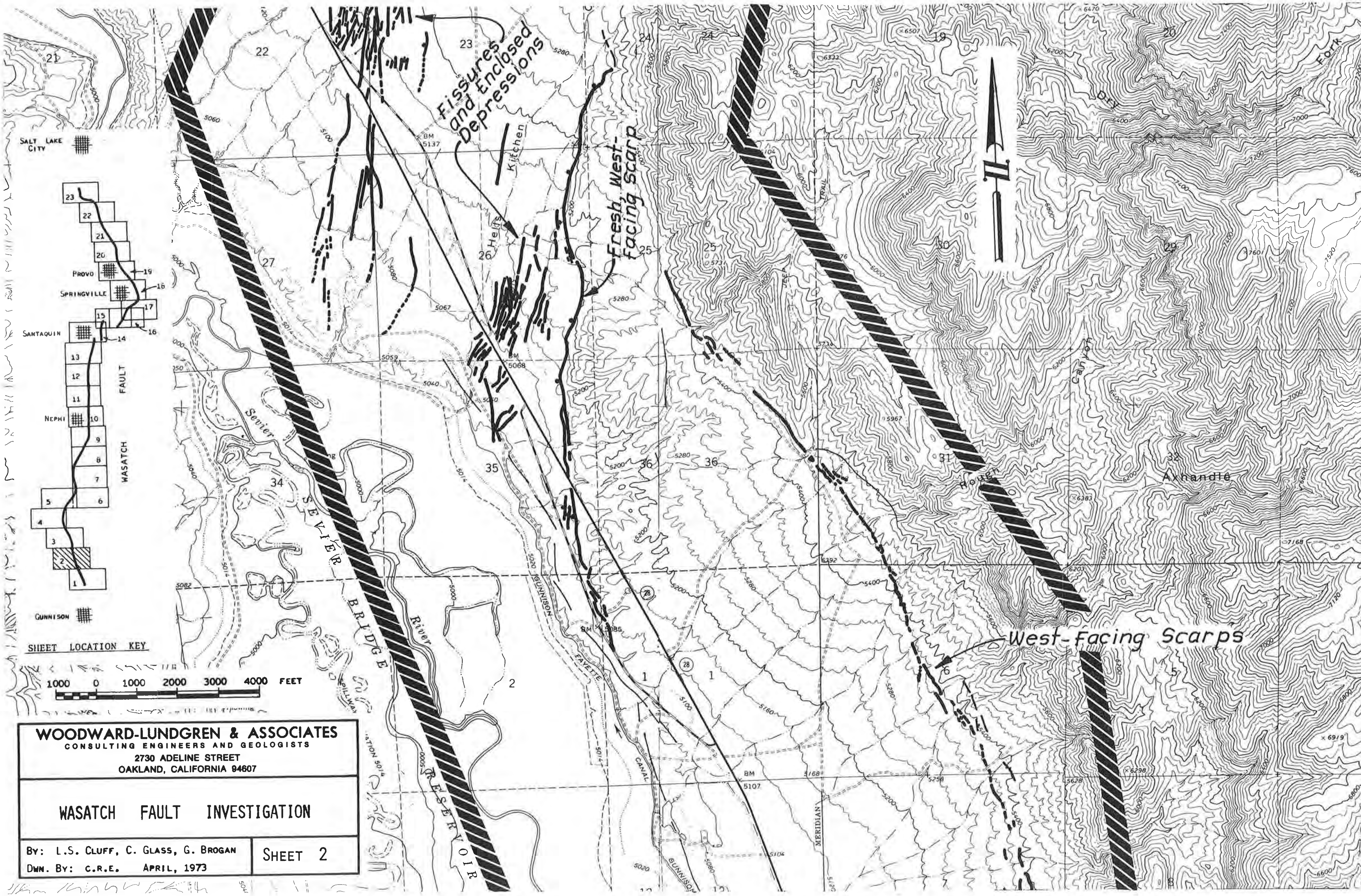
1000 0 1000 2000 3000 4000 FEET

WOODWARD-LUNDGREN & ASSOCIATES
CONSULTING ENGINEERS AND GEOLOGISTS
2730 ADELINE STREET
OAKLAND, CALIFORNIA 94607

WASATCH FAULT INVESTIGATION

BY: L.S. CLUFF, C. GLASS, G. BROGAN
DWN. BY: C.R.E. APRIL, 1973

SHEET 1



WOODWARD-LUNDGREN & ASSOCIATES
CONSULTING ENGINEERS AND GEOLOGISTS
2730 ADELINE STREET
OAKLAND, CALIFORNIA 94607

WASATCH FAULT INVESTIGATION

By: L.S. Cluff, C. Glass, G. Brogan
Dwn. By: C.R.E. April, 1973

Sheet 2

Faults in Bedrock

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY

1000 0 1000 2000 3000 4000 FEET

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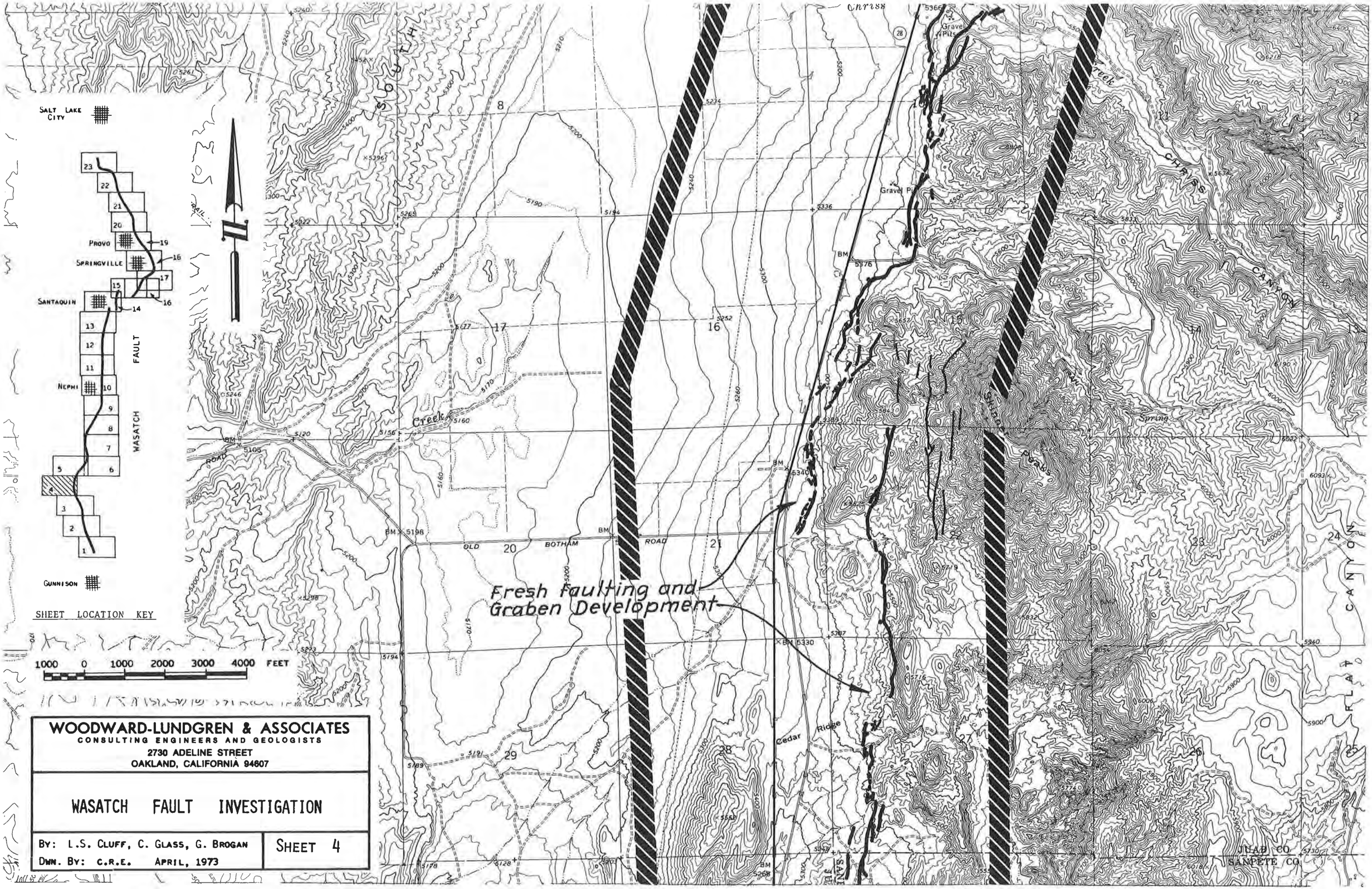
SHEET 3



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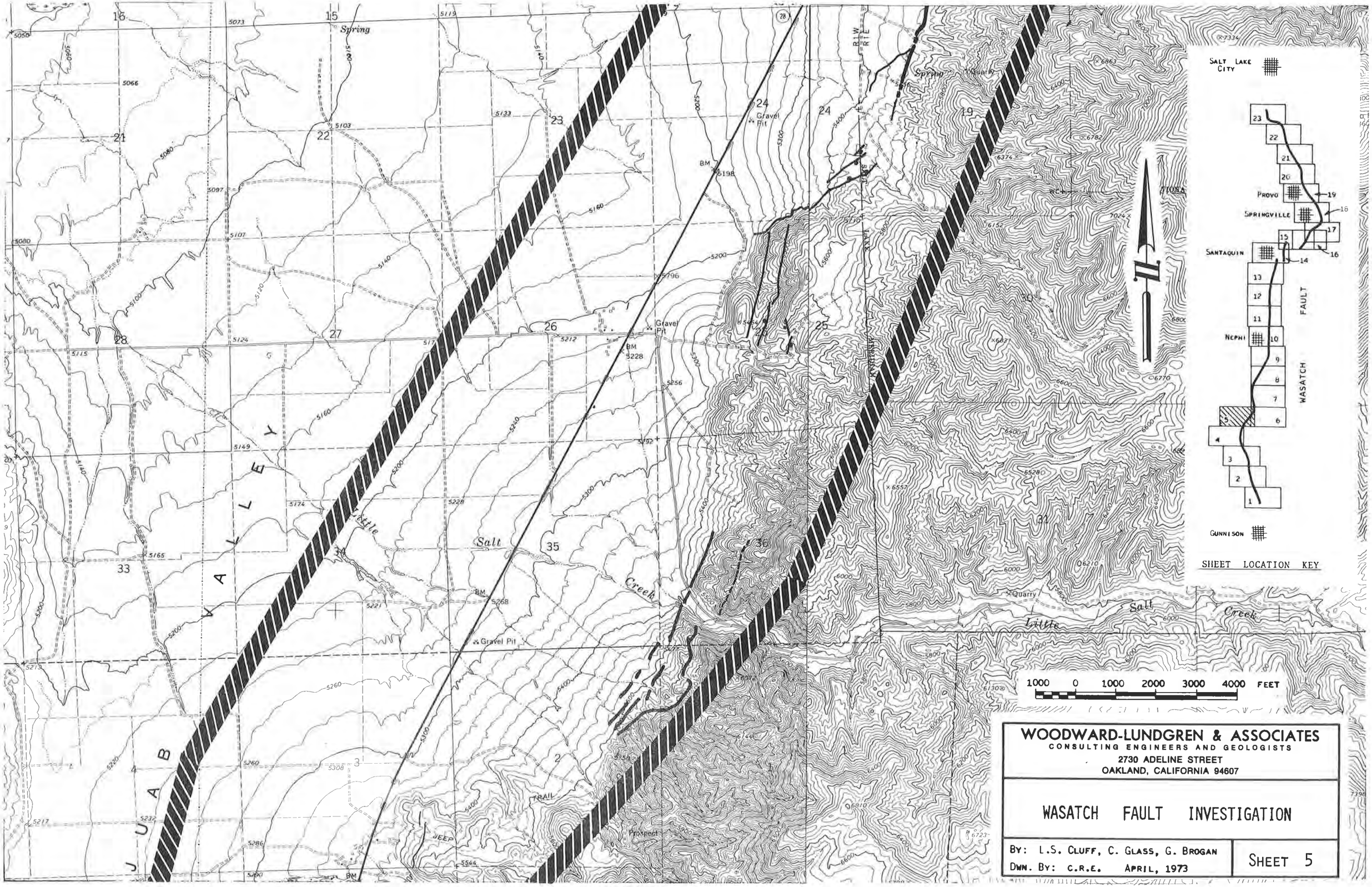
SHEET 4



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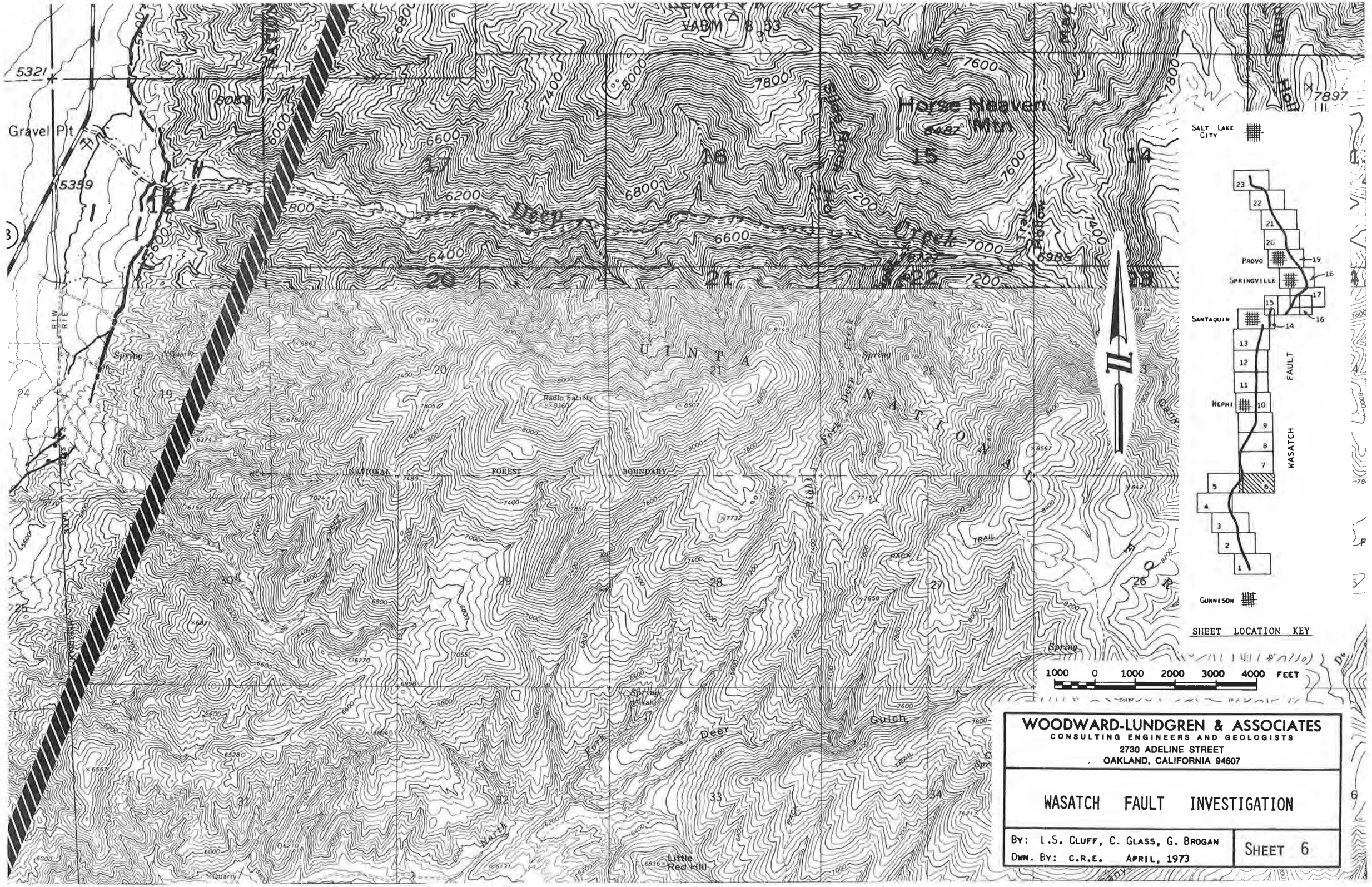
SHEET 5



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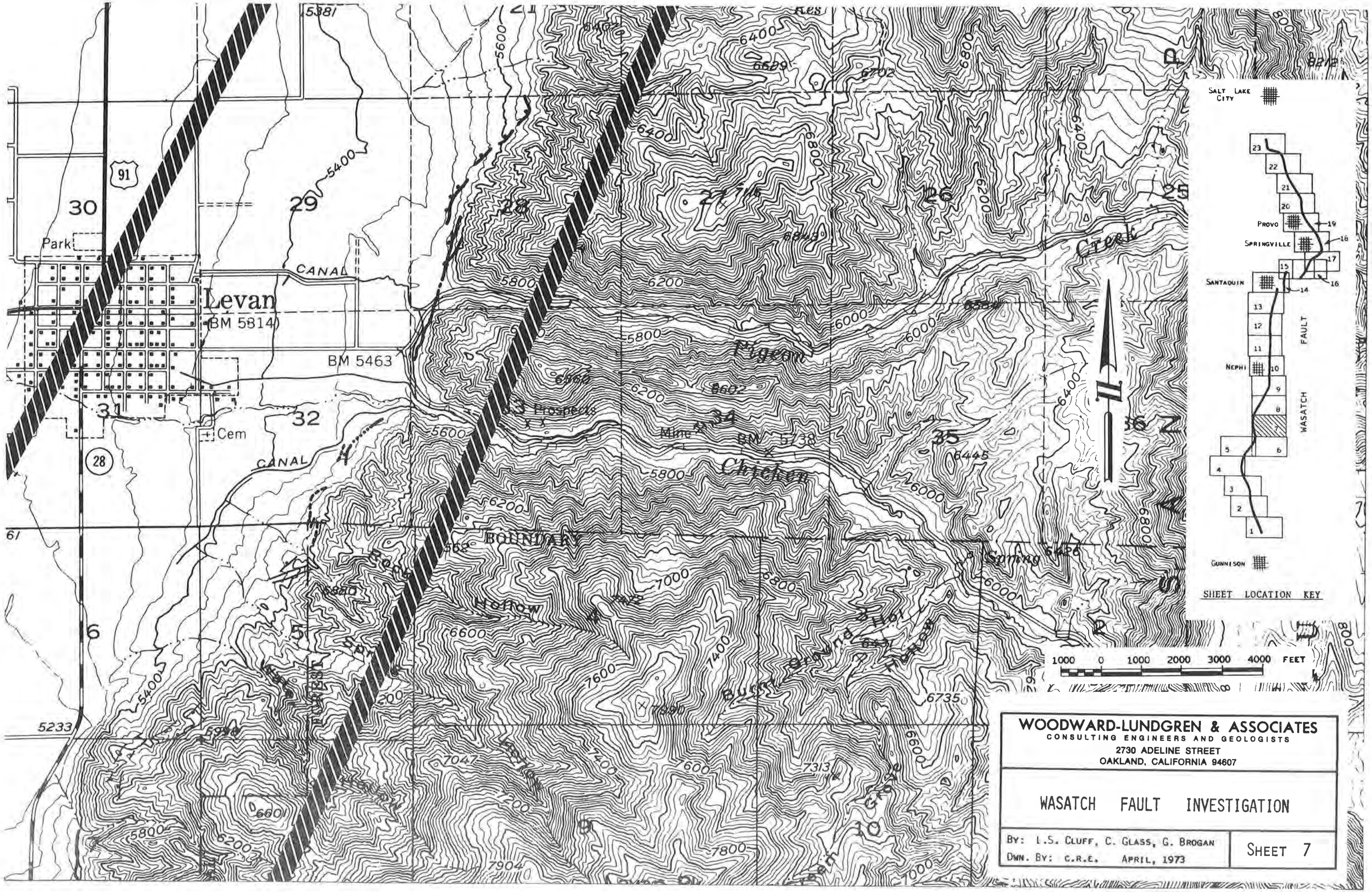
SHEET 6



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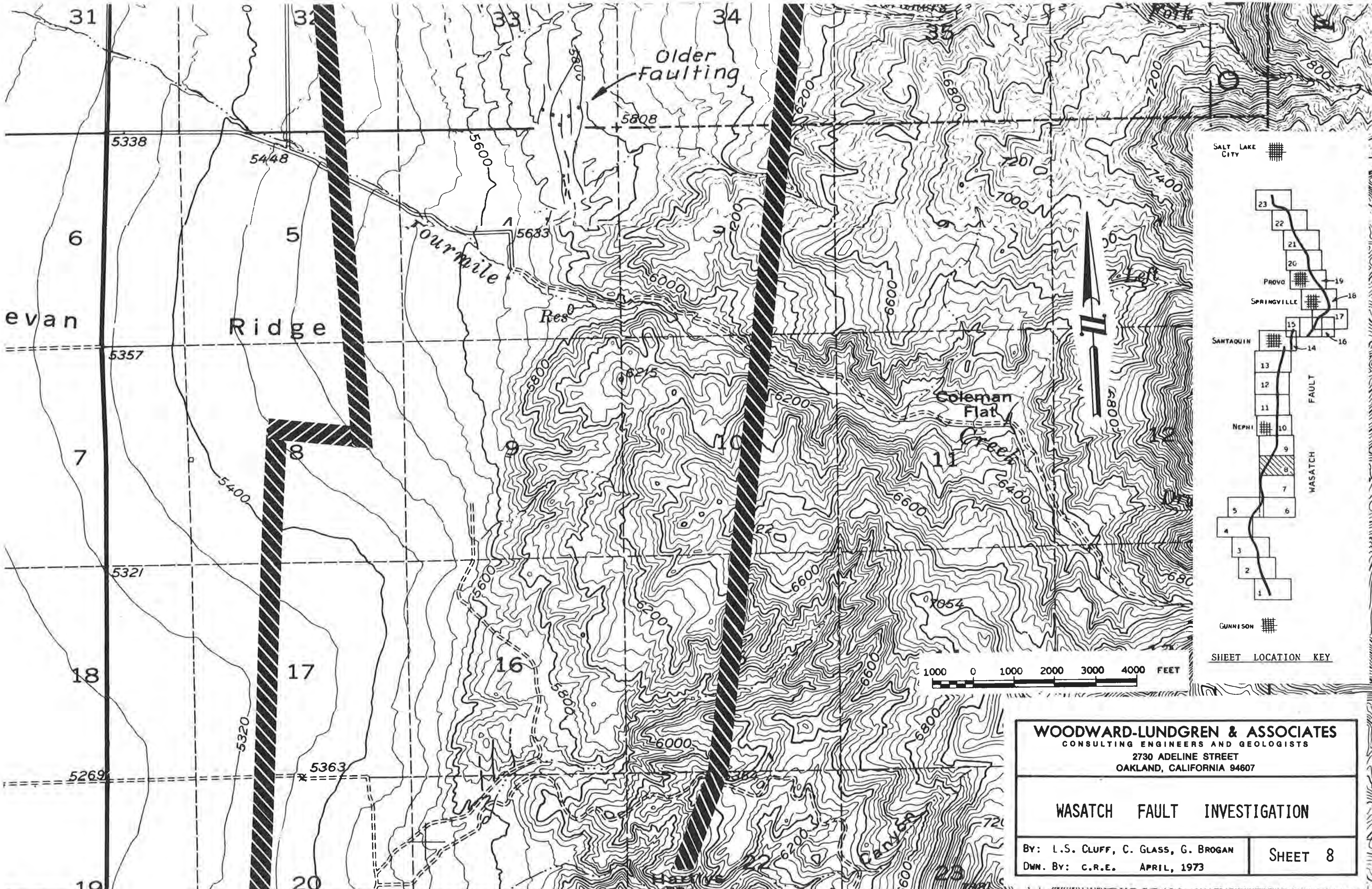
SHEET 7



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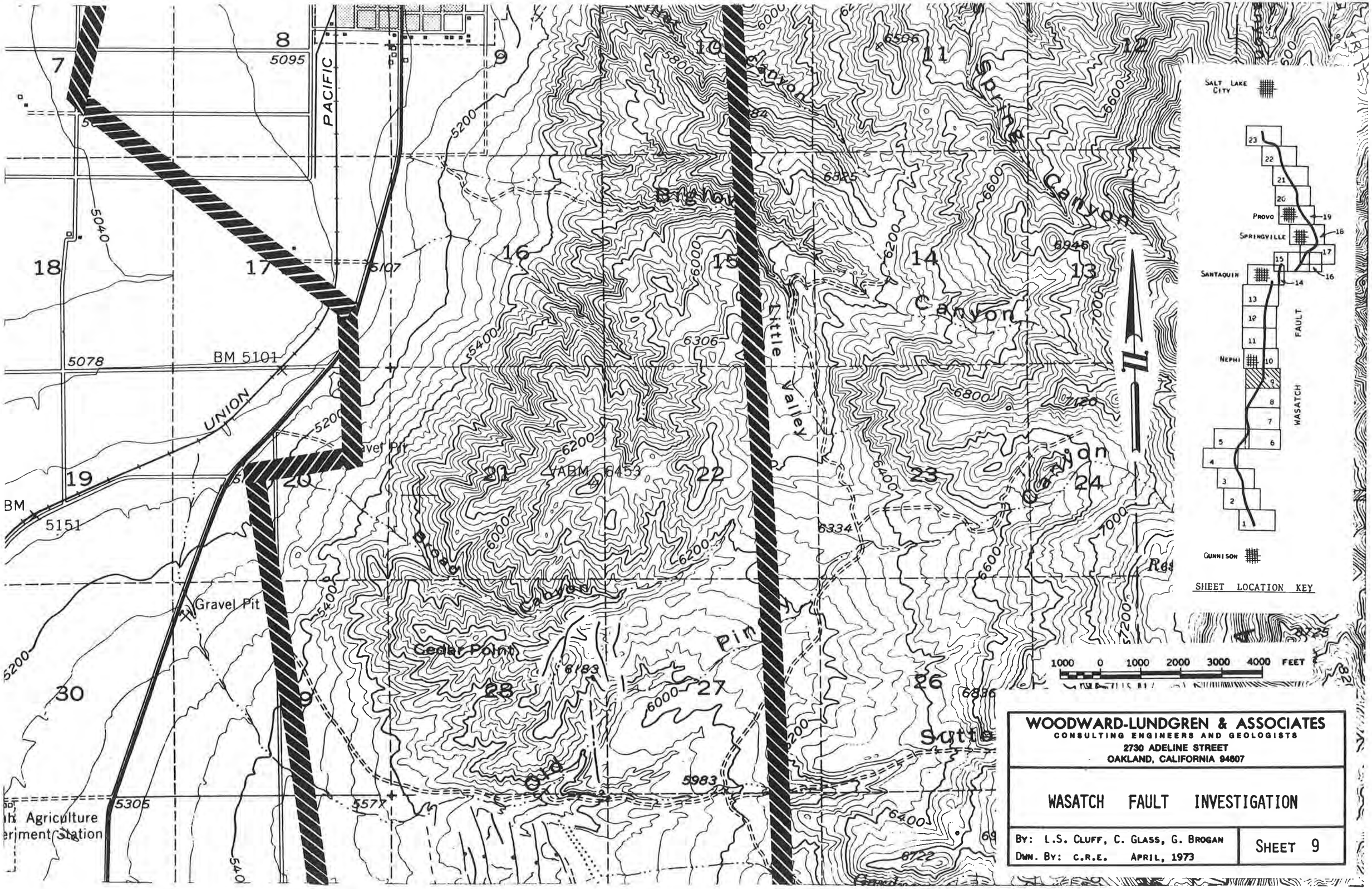
SHEET 8



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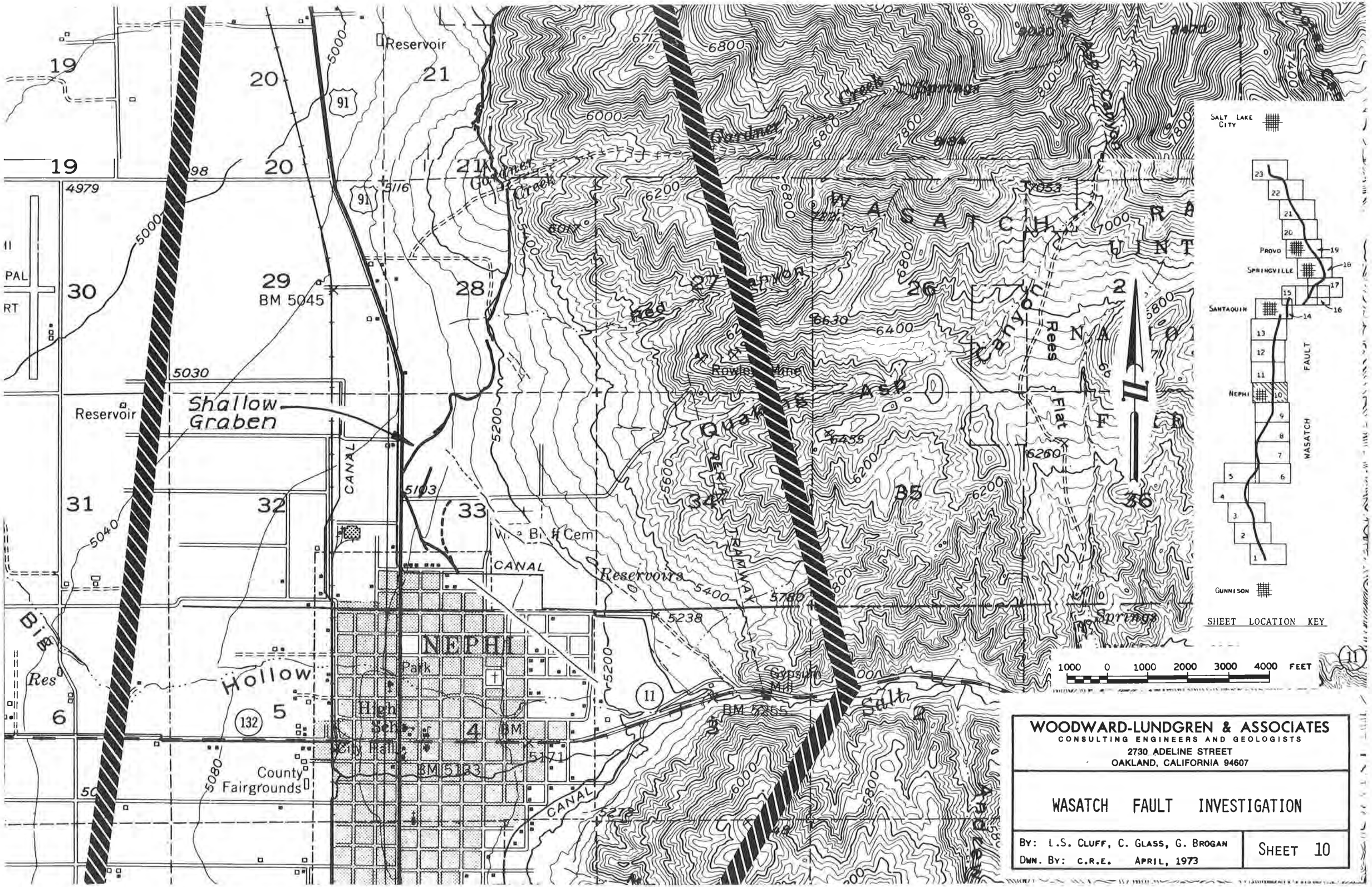
SHEET 9



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SHEET 10

Landslide Debris

Fresh, West-Facing Scarps

Landslide Debris

Gravel Pit

Reservoir

BM 5028

BM 4916

BM 4918

Currant Creek

Willow Creek

Left Fork Middle Ridge

Water Hollow

Wildcat Gulch

Little Canyon

Ingram Canyon

Couch Canyon

South Basin

North Basin

Mt. N

Little Birch Cr.

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY

1000 0 1000 2000 3000 4000 FEET

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SHEET 11

SPILLWAY

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY

1000 0 1000 2000 3000 4000 FEET

Artesian Wells

Springs

Well

Starr

Menderhall

Fresh, West-Facing Scarps

North Creek

Bald Mtn

Mona

Landslide Debris

Pole Canyon

Canyon

Wolf Pass

Mona

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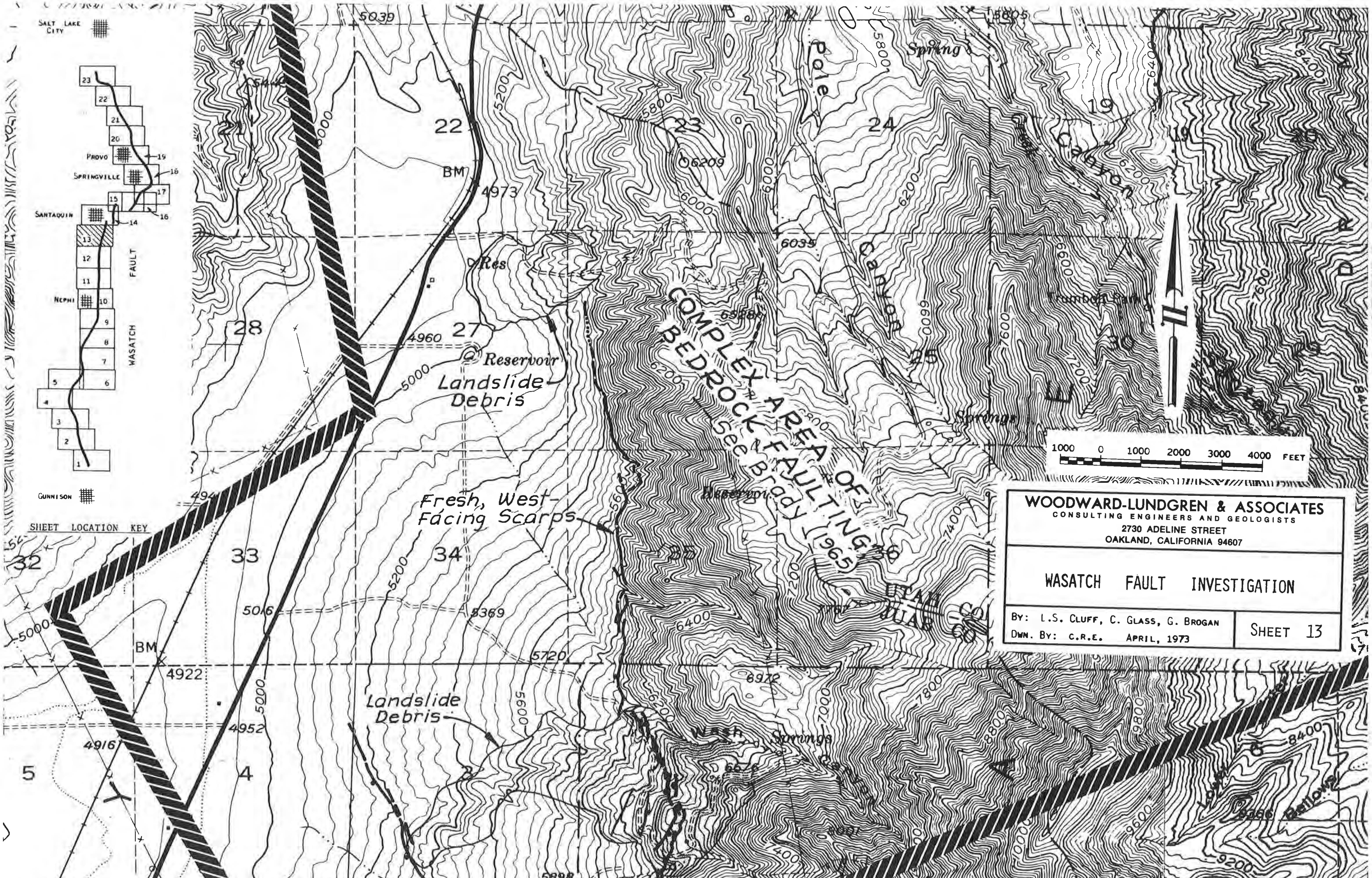
SHEET 12



SALT LAKE CITY
PROVO
SPRINGVILLE
SANTAQUIN
NEPHI
GUNNISON
WASATCH FAULT
SHEET LOCATION KEY
COMPLEX AREA OF BEDROCK FAULTING
See Brady 1965
Landslide Debris
Fresh, West-Facing Scarps
Reservoir
Res
Pole Canyon
Canyon
Spring
Springs
Wash
Trumbolt Park
UTAH
JUAB
CO
1000 0 1000 2000 3000 4000 FEET
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WASATCH FAULT INVESTIGATION
BY: L.S. CLUFF, C. GLASS, G. BROGAN
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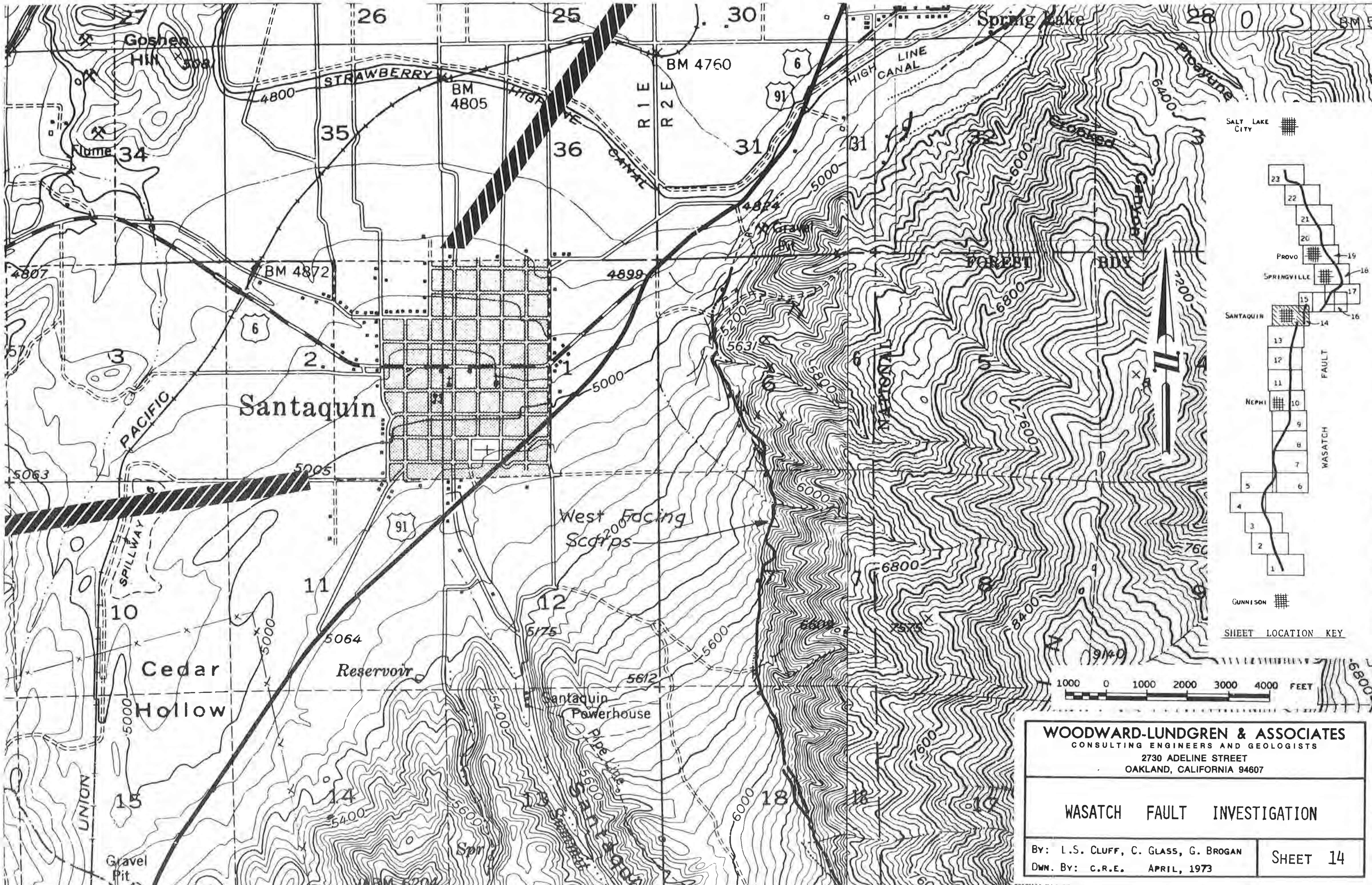
SHEET 13



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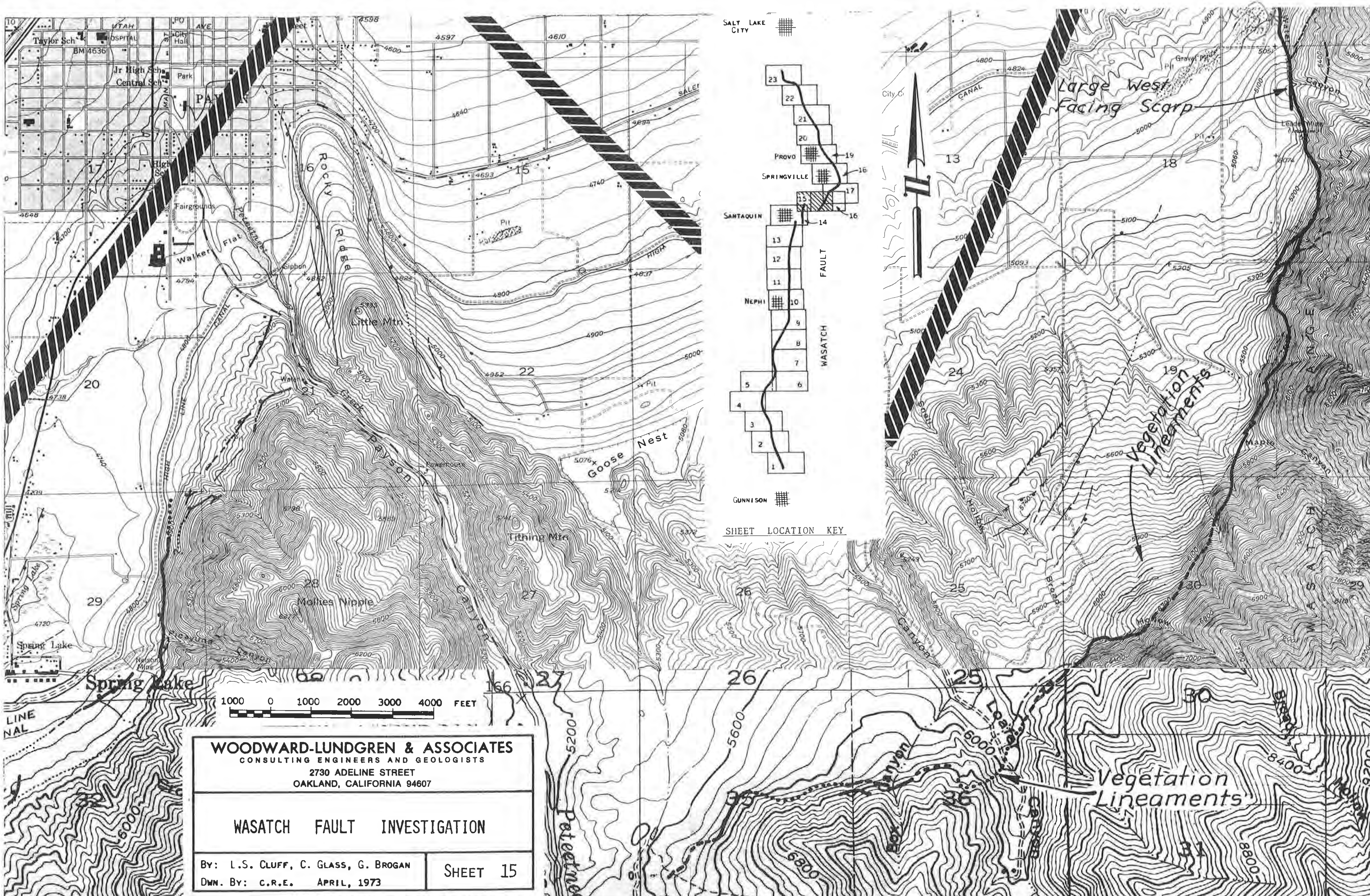
SHEET 14



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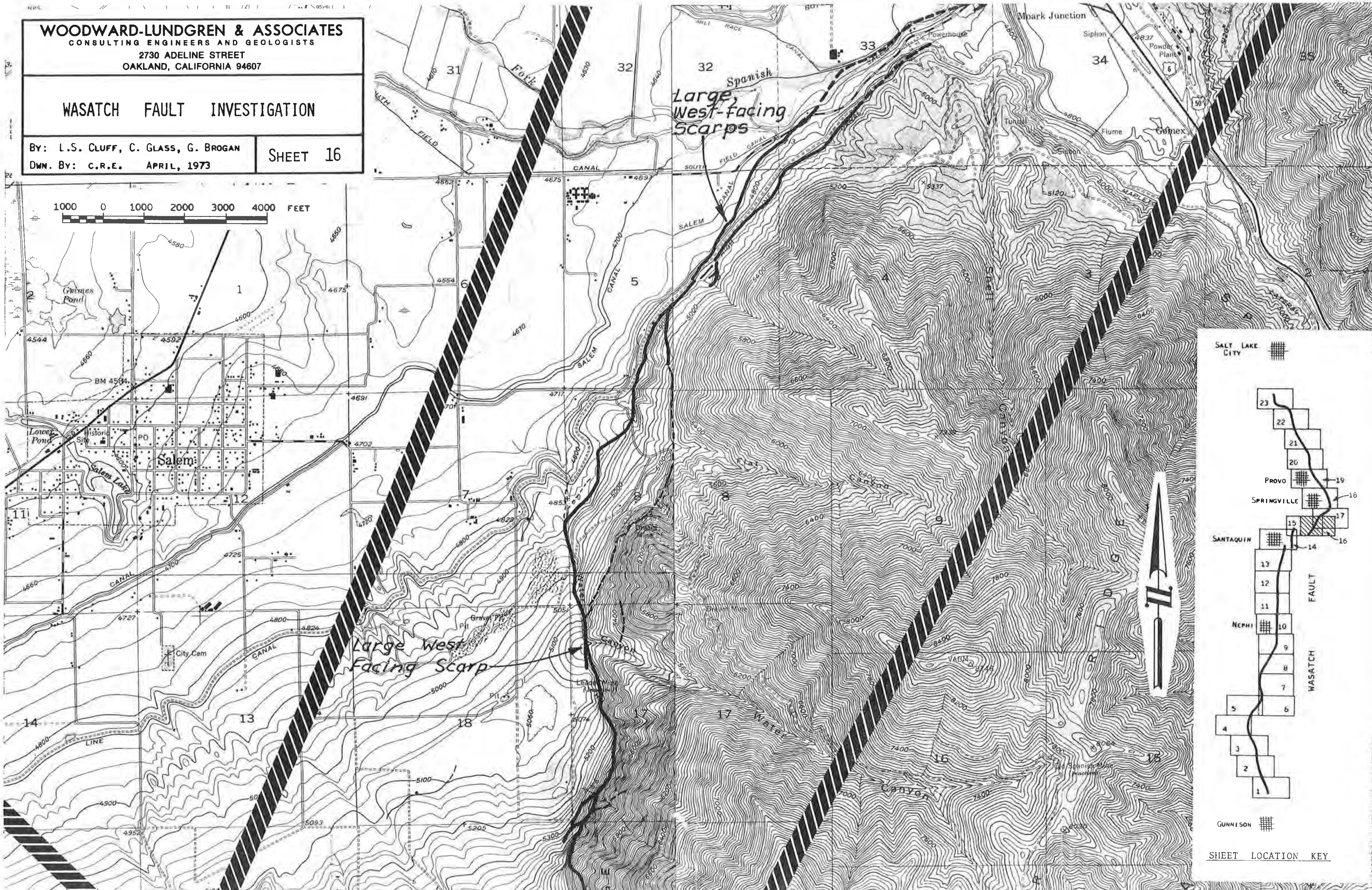
Sheet 15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WASATCH FAULT INVESTIGATION
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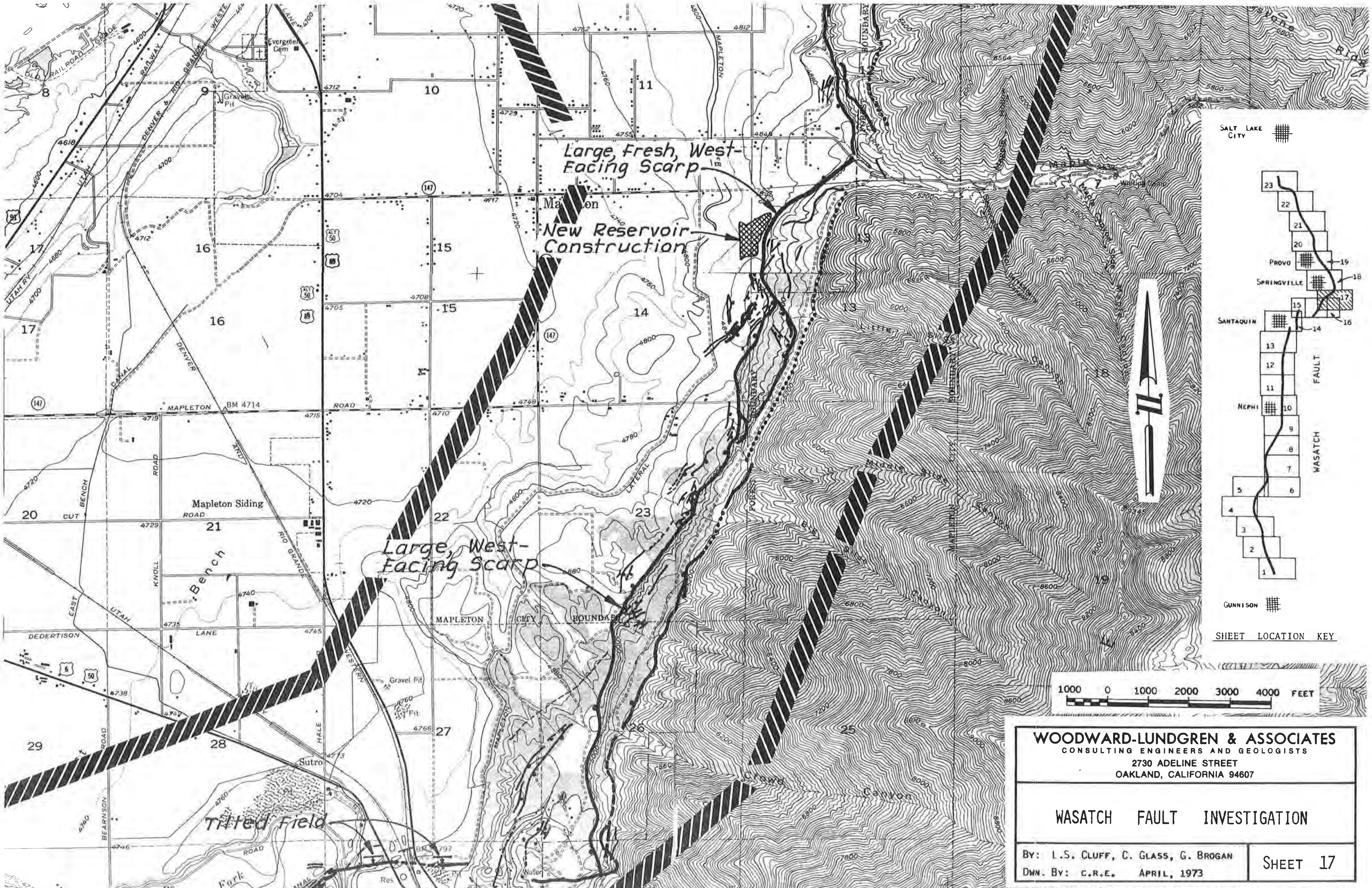
SHEET 16
1000 0 1000 2000 3000 4000 FEET
Large, West-facing Scarps
Large West Facing Scarp
Salem
Salem Lake
Lower Pond
Grimes Pond
City Cem
Spanish Fork
Moark Junction
Powerhouse
Siphon
Powder Plant
Tunnel
Flume
Gomex
Flat Canyon
Water Canyon
SHEET LOCATION KEY
SALT LAKE CITY
PROVO
SPRINGVILLE
SANTAQUIN
NEPHI
GUNNISON
WASATCH FAULT


Large, Fresh, West-Facing Scarp
New Reservoir Construction
Large, West-Facing Scarp
Tilted Field
Mapleton
Mapleton Siding
MAPLETON ROAD
MAPLETON CITY BOUNDARY
Evergreen Cem
Gravel Pit
Sutro
DENVER & RIO GRANDE WESTERN RAILWAY
UTAH RAILWAY
Little Dry Canyon
Middle Slide Canyon
Crowd Canyon
Maple Canyon
1000 0 1000 2000 3000 4000 FEET
SALT LAKE CITY
PROVO
SPRINGVILLE
SANTAQUIN
NEPHI
GUNNISON
WASATCH FAULT
SHEET LOCATION KEY
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SHEET 17

Two Grabens From Soil Failure

Fresh, West-Facing Scarps

Low, Wet, Ground-Possible Graben

Shallow Break in Slope

Spring-ville Fault

Tilted Fields

WASATCH FAULT

SHEET LOCATION KEY

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

1000 0 1000 2000 3000 4000 FEET

MAPLETON CITY BOUNDARY

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SHEET 18

Fault Locations Approximate
Only Major Breaks Shown
Due to Urban Development

Old Landslide

Tilted Fields

Graben

New Provo Drinking Water Pressure Tank

Gravel Pit Obscures Fault Features

Area of Low, Wet Ground

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY

1000 0 1000 2000 3000 4000 FEET

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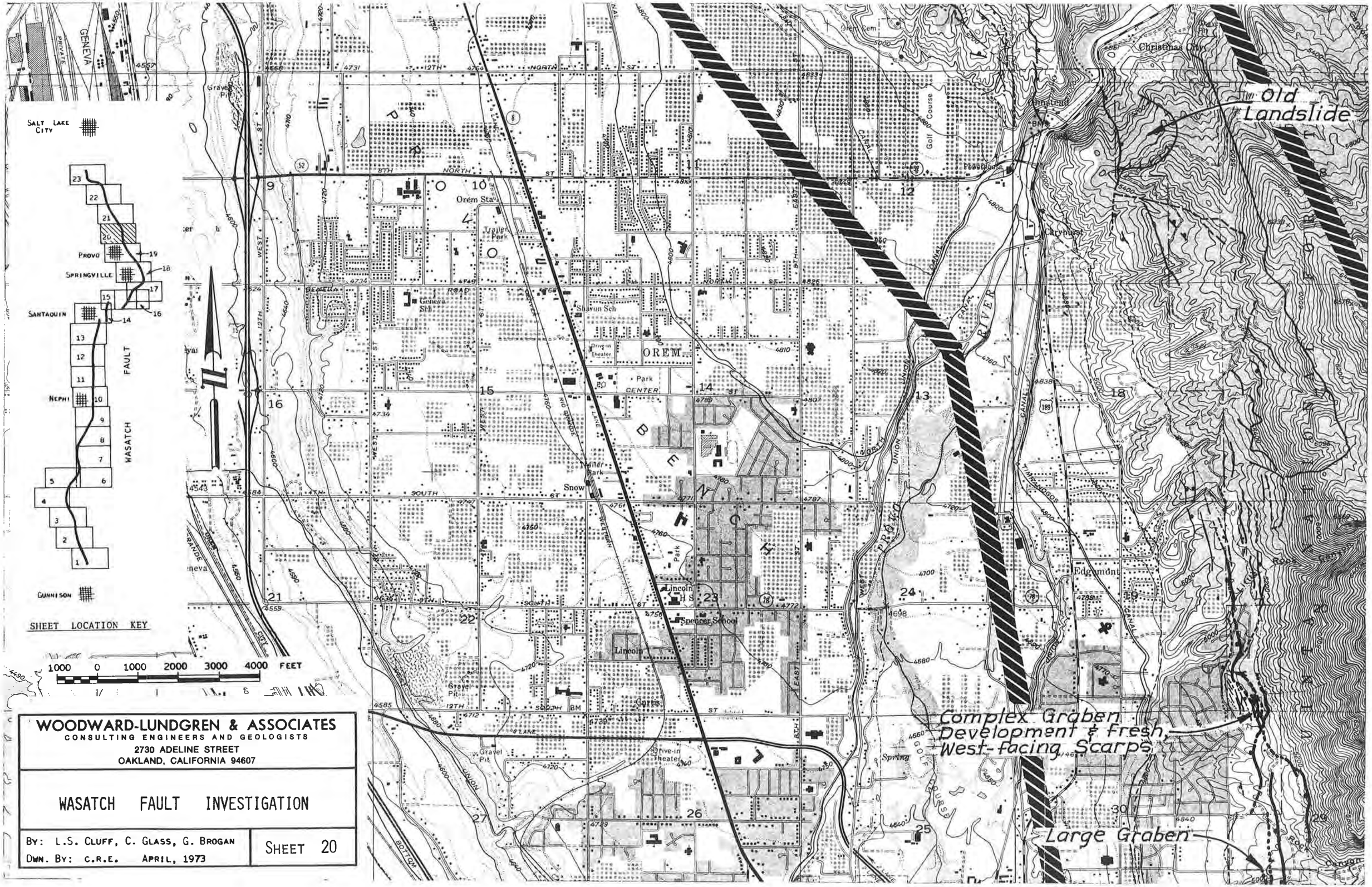
SHEET 19



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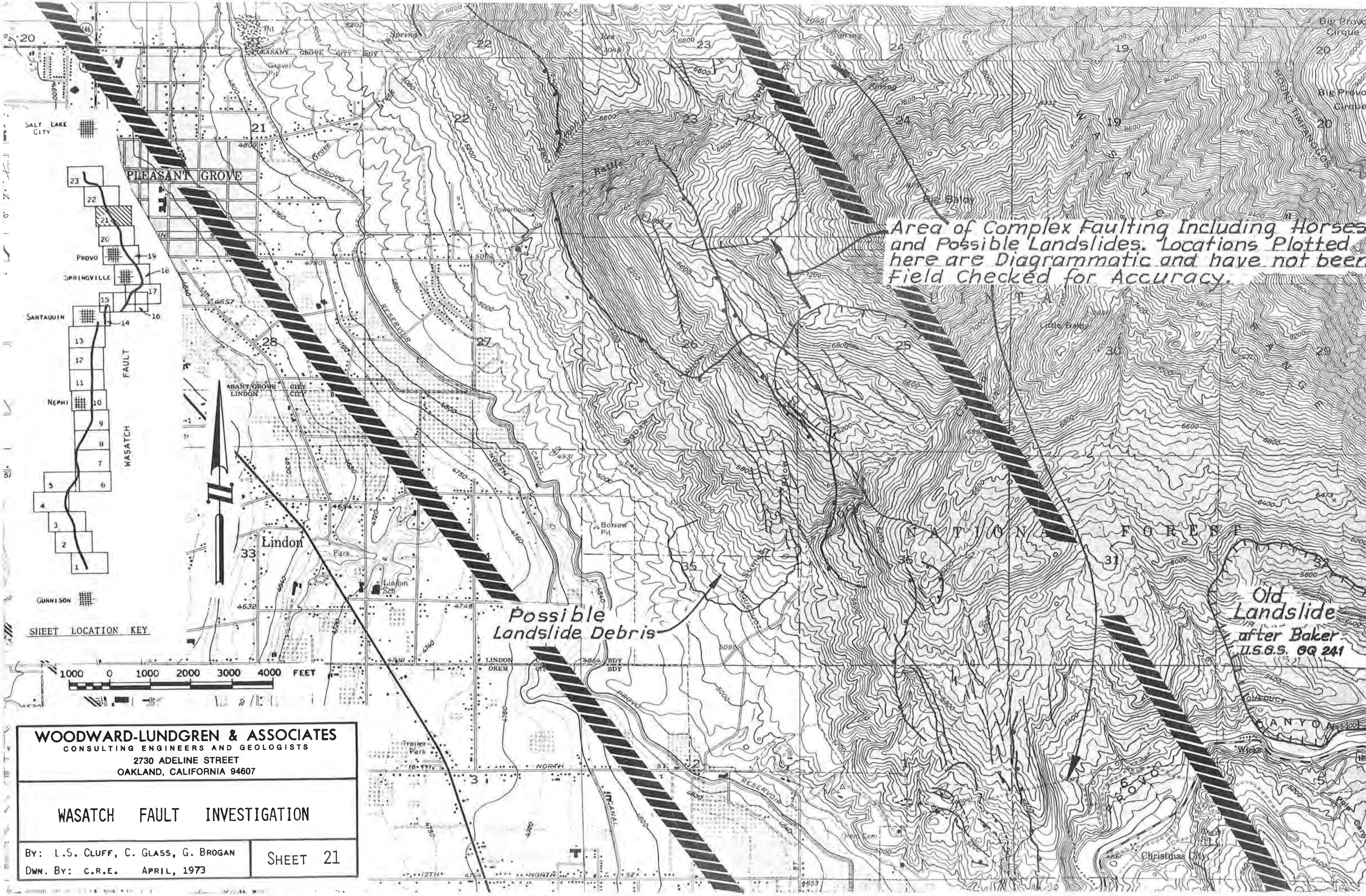
SHEET 20


Area of Complex Faulting Including "Horses" and Possible Landslides. Locations Plotted here are Diagrammatic and have not been Field Checked for Accuracy.
Possible Landslide Debris
Old Landslide after Baker U.S.G.S. GQ 241
PLEASANT GROVE
Lindon
SHEET LOCATION KEY
SALT LAKE CITY
PROVO
SPRINGVILLE
SANTAQUIN
NEPHI
GUNNISON
WASATCH FAULT
1000 0 1000 2000 3000 4000 FEET
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SHEET 21

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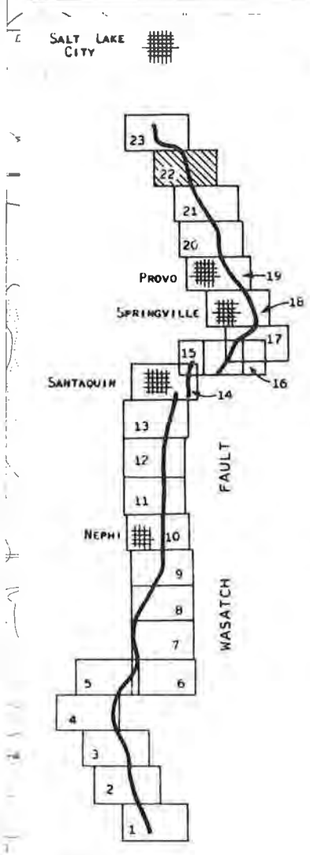
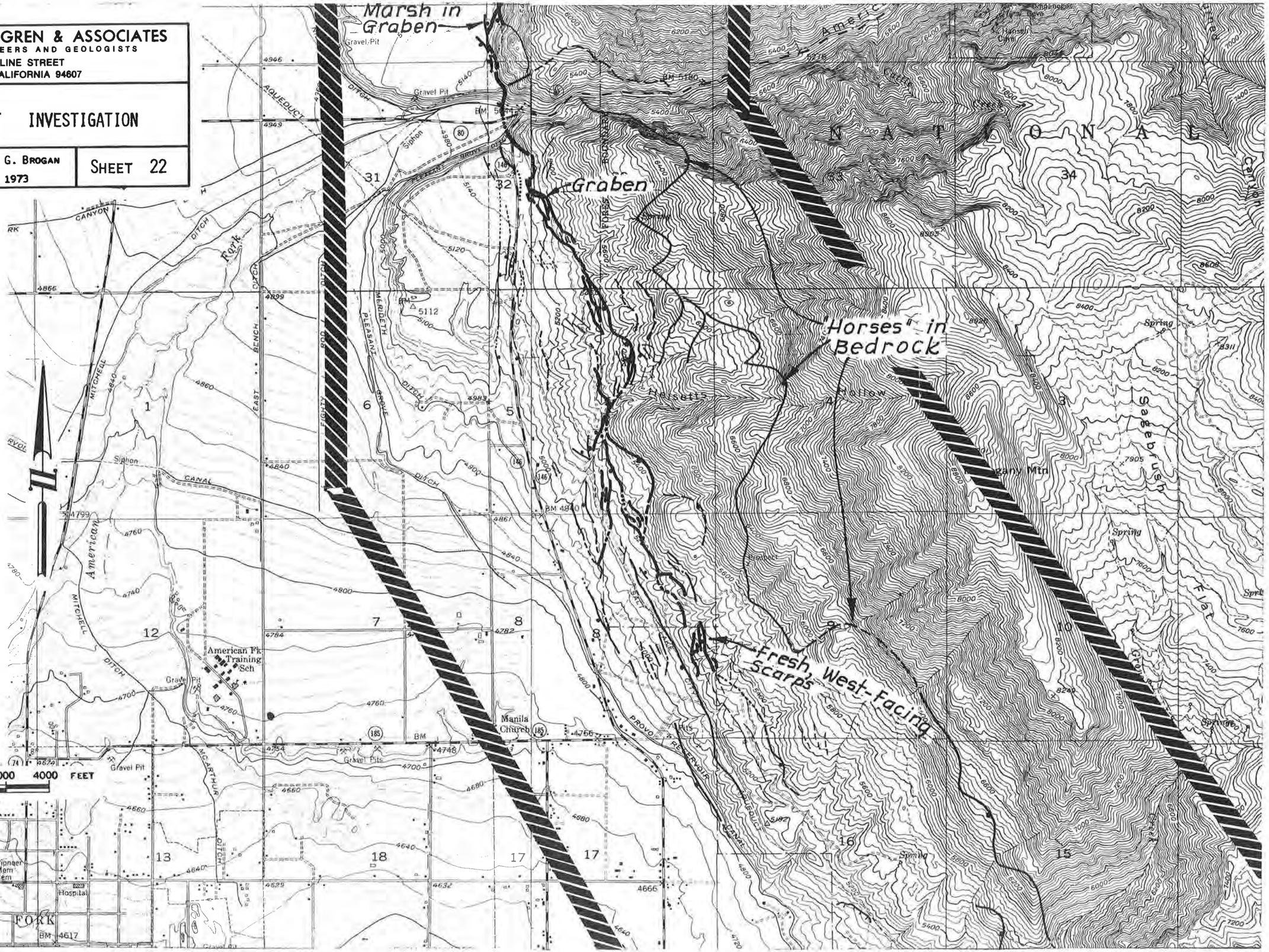
SHEET 22





FAULTING COMPLICATED BY AREA OF COMPLEXLY BROKEN BEDROCK

Graben

Graben

Graben

Fresh, West-Facing Scarp

1000 0 1000 2000 3000 4000 FEET

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SHEET 23

SALT LAKE CITY

PROVO

SPRINGVILLE

SANTAQUIN

NEPHI

GUNNISON

WASATCH FAULT

SHEET LOCATION KEY