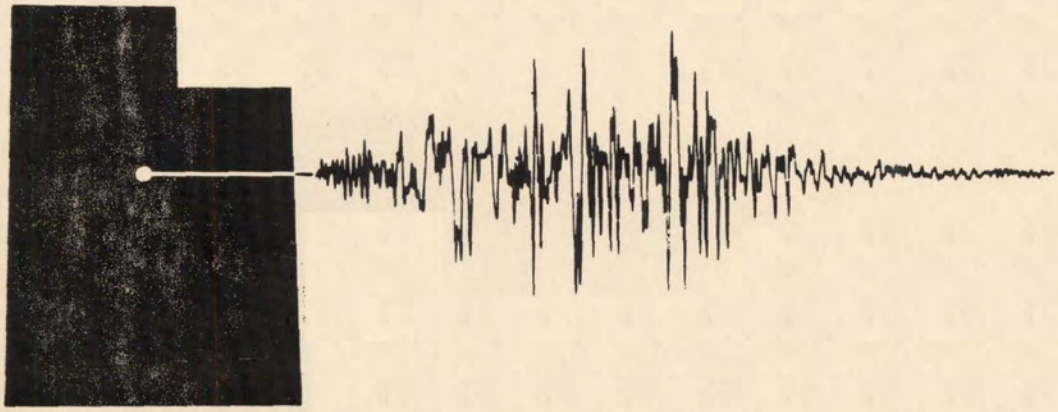

Seismotectonic Study

for
Mona Dam and Reservoir
Central Utah Project, Utah

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ENGINEERING AND RESEARCH CENTER
SEISMOTECTONIC SECTION
DENVER, COLORADO

SEISMOTECTONIC STUDY FOR MONA DAM AND RESERVOIR

Central Utah Project, Utah

by

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SEISMOTECTONIC REPORT 86-4

Seismotectonic Section
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SUMMARY

This report presents the results of a seismotectonic study for Mona Dam, Central Utah Project, Utah. The dam is located within the ISB (Intermountain seismic belt) near the eastern margin of the Basin and Range Province (fig. 1). Physiography, north-trending late Cenozoic and late Quaternary fault patterns, and geologic and seismologic studies of historical earthquakes show that the evolution of this region has been dominated by generally east-west crustal extension. Mona dam is located on Long Ridge, a north and northeast-trending range block about 6 km from the Wasatch fault and the reservoir occupies a portion of the adjacent topographic and structural basin called Juab Valley. No faults are mapped in the Eocene volcanic rocks within the foundation of the proposed dam, but late Quaternary faults are inferred on the margins of Long Ridge. The Juab Valley fault on the east side of Long Ridge is inferred beneath Mona Reservoir, a few hundred meters upstream of the dam.

Seismotectonic hazards to Mona Dam include: ground shaking from seismic sources near the dam, surface displacements in the reservoir, and reservoir seiche waves generated by the combination of surface displacements in the reservoir and tilt of the reservoir surface. The most likely sources for earthquakes in the vicinity of Mona Dam are the Wasatch fault with an MCE of 7 1/2 at a distance of 3 to 6 km and a local earthquake of magnitude 6 to 6 1/2 in the immediate vicinity of the dam. Other late Quaternary faults are inferred in the vicinity of the dam, but MCEs associated with these faults are smaller than that associated with the Wasatch fault and further from the dam than the local earthquake. No faults or shears have been identified in the foundation of the proposed dam, therefore no significant surface displacements should be considered in the design and analysis of the dam. However, joints are present in the dam foundation and a large-magnitude earthquake on the Wasatch fault could result in small adjustments on these pre-existing joints. Seiche waves in the reservoir will accompany a large-magnitude earthquake on the Wasatch fault. The seiche will result from the combination of a possible 1 m displacement in the reservoir on the Juab Valley fault and tilt resulting from differential subsidence in the hanging wall of the Wasatch fault estimated at 0.75 m across the reservoir.

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1. INTRODUCTION

1.1 Location

Mona Dam and Reservoir are located on Currant Creek in northern Juab Valley about 70 km south of Salt Lake City and about 20 km north of Nephi. Juab Valley is near the western boundary of the study area of the Central Utah Regional Seismotectonic Study which discusses the characteristics of historical seismicity in the region and reports geologic investigations of late Quaternary faulting in the back valleys of the Wasatch Mountains (Sullivan and others, 1986). The existing earthfill dam was constructed in the early 1900s and stores about 19,000 acre-feet of water. A roller-compacted concrete dam, 15 m (50 ft) high and 91 m (300 ft) long, has been proposed immediately downstream to replace the present dam (USBR, 1986). The new dam will also impound about 19,000 acre-feet of water (USBR, 1986).

1.2 Purpose and Scope

This report presents the results of a seismotectonic study for the existing and proposed Mona Dam based on a review of available published literature, the results of USBR site geologic investigations, recently completed regional seismotectonic investigations in central Utah (Sullivan and others, 1986), and limited reconnaissance-level seismotectonic investigations in the damsite and reservoir area. The report provides MCEs (Maximum Credible earthquakes) for design and analysis of the dam and discusses geodetic effects in the reservoir area which could accompany the occurrence of the MCEs. The level of investigations conducted for this report should be considered adequate for final design considerations. No further seismotectonic investigations are recommended at this time.

2. TECTONIC SETTING

Mona Dam is located near the eastern margin of the Basin and Range Province (fig. 1). Physiography, north-trending late Cenozoic and late Quaternary fault patterns, and geologic and seismologic studies of historical earthquakes show that the evolution and contemporary tectonics of the Basin and Range are dominated by generally east-west crustal extension. Coincident with the ISB (Intermountain seismic belt) on the eastern margin of the Basin and Range, north-trending late Cenozoic and late Quaternary normal faults with lower average slip rates and longer average recurrence intervals of surface displacements are present in the back valleys of the Wasatch Mountains (Sullivan and others, 1986) and the Basin and Range Transition zone. Further east late Quaternary faults are absent in the Colorado Plateau and Middle Rocky Mountains, regions dominated by regional crustal compression (Zoback and Zoback, 1980).

2.1 Juab Valley and Long Ridge

Mona Dam is located on Long Ridge, a north and northeast-trending range block about 6 km west of the Wasatch fault. The reservoir occupies a portion of Juab Valley (fig. 2). Juab Valley is a topographic and structural basin about 60 km long and 5 - 10 km wide, inferred to be bounded by normal faults on the basis of gravity data (Cook and Berg, 1961; Zoback, 1983). Valley fill consisting of alluvial fan, lacustrine, and floodplain deposits is at least 300 m (995 ft) thick and may reach a thickness of more than 1200 m (4000 ft) (Hintze, 1962). The valley was occupied by Lake Bonneville during the late Pleistocene and shorelines are evident on the margins of the valley. The northern part of the valley in which Mona Dam and reservoir are located is drained by Currant Creek, which exits the valley in a narrow gorge entrenched through Long Ridge (fig. 2).

The northern portion of Long Ridge consists of complexly folded and faulted Paleozoic rocks unconformably overlain by the Laguna Latite, a sequence of Eocene age pyroclastic rocks and flows, which has been folded into an anticline (Muessig, 1951). The northern part of the ridge is asymmetric in section with greater relief on the steeper west side bordering Goshen Valley where a normal fault has been inferred (Muessig, 1951). There is no escarpment on the east side; the east slope of Long Ridge merges with the unconsolidated deposits of Juab Valley. However, a fault also has been inferred on the east side near the contact between the Laguna Latite and unconsolidated deposits. This inferred fault trends beneath the reservoir, within a few hundred meters of Mona Dam (Muessig, 1951; Zoback, 1983; USBR, 1986).

2.2 Wasatch fault

The Wasatch fault is a 370-km-long, north-trending normal fault bounding the east side of Juab Valley about 6 km east of Mona Dam (figs. 1 and 2). Previous geologic studies have shown that repeated surface displacement events averaging about 2 m have occurred on the fault during the Holocene (Schwartz and Coppersmith, 1984) and indicate an average late Quaternary slip rate of about 1 mm/yr for the fault. Six to 10 major segments of the fault, each 30 to 70 km in length, are thought to have ruptured independently.

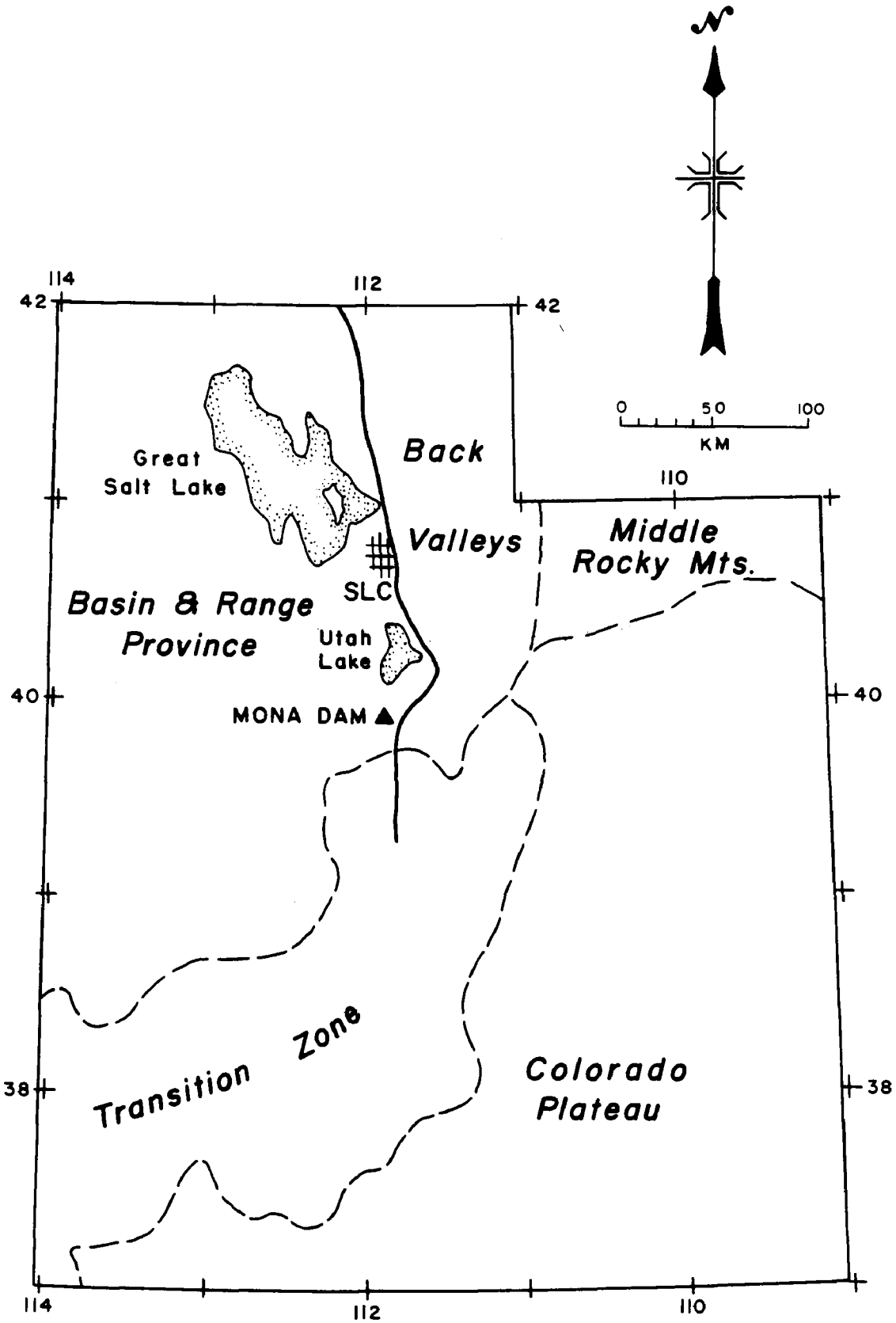

Figure 1 – Physiographic regions in the vicinity of Mona Dam. (Wasatch Fault shown with heavy line.)

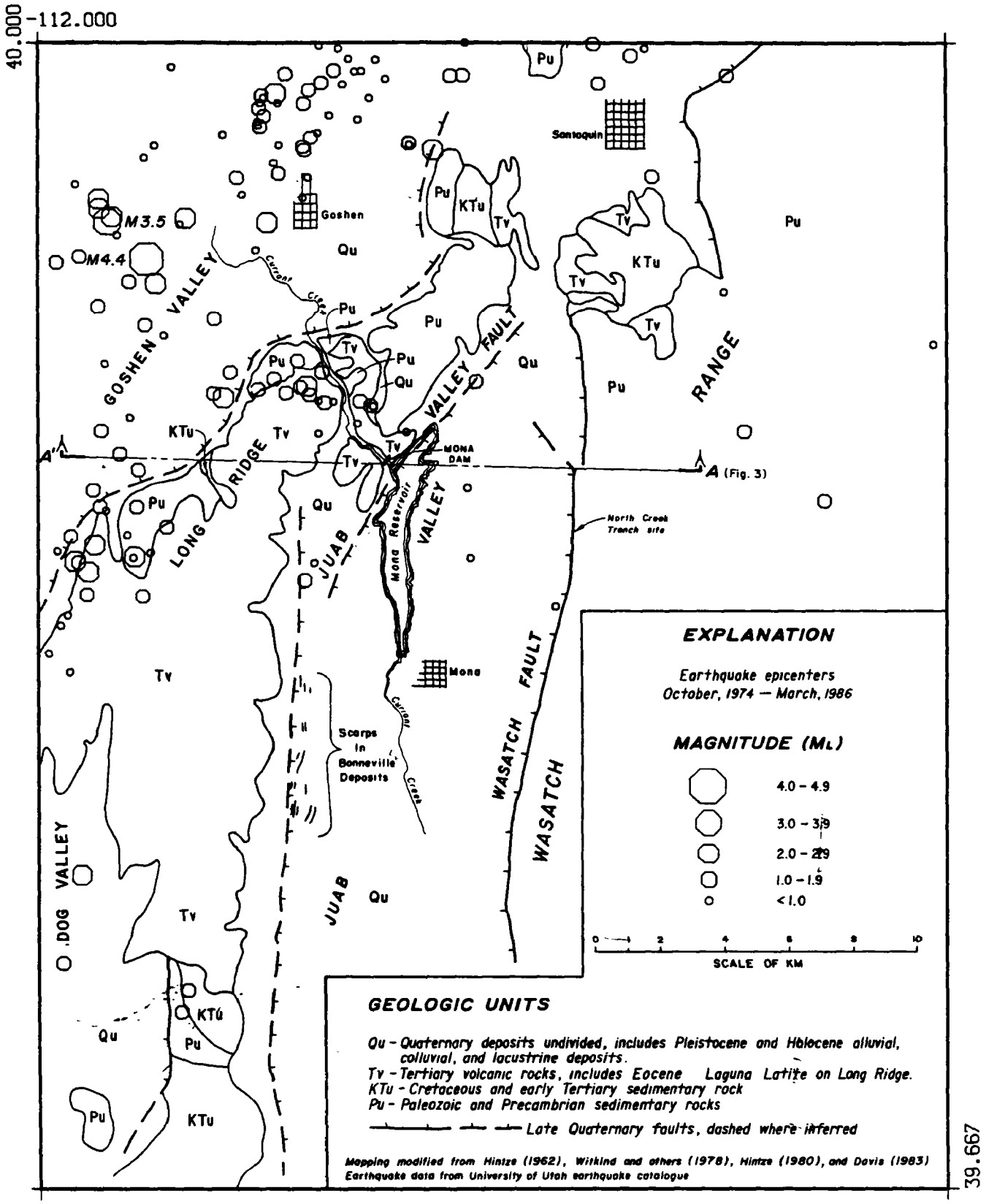

Figure 2 — Seismotectonic map of Mona Reservoir and vicinity.

The Nephi segment of the Wasatch fault on the east side of Juab Valley is the closest segment to Mona Dam (fig. 2). At the North Creek trench site on this segment of the fault an alluvial fan containing a burn layer dated at 4580 ^{14}C years is displaced 7 +/- 0.5 m (Schwartz and Coppersmith, 1984). Trench stratigraphy and scarp profiling are interpreted as indicating that three surface displacement events of 2.0 - 2.6 m have occurred since deposition of the fan with the most recent occurring 300 - 500 years ago (Schwartz and Coppersmith, 1984).

2.3 Historic Seismicity

Mona Dam is located within the Intermountain seismic belt (ISB), a 100 km wide zone of contemporary seismicity on the eastern margin of the Basin and Range. Centered approximately on the Wasatch fault in central Utah, the ISB is considered to have the highest level of earthquake risk in the United States outside of California and Nevada (Arabasz and Smith, 1979). Commonly observed features of earthquake occurrence within the ISB have been described by Smith and Sbar (1974), Smith (1978) and Arabasz and Smith (1981). Among these features are 1) diffuse seismicity which shows only general correlation with locations exhibiting late Quaternary surface faulting; 2) an apparent lack of correlation between small to moderate-magnitude earthquakes and mapped faults; 3) shallow focal depths (less than 15 to 20 km); 4) sporadic occurrence of earthquakes both spatially and temporally; and 5) a persistent pattern of normal faulting indicating predominantly east-west extension (Sullivan and others, 1986).

A notable feature of the Wasatch fault south of Salt Lake City is the lack of historic or instrumental seismicity directly associated with the fault (Sbar and others, 1972; Arabasz and others, 1980). A composite focal mechanism from microearthquakes recorded in Juab Valley was interpreted as indicating normal faulting on a northeast trending fault with sense of displacement opposite to that of the Wasatch fault, suggesting the events may be associated with the fault on the west side of Juab Valley (Sbar and Smith; 1972) although the validity of this mechanism has been questioned (McKee and Arabasz, 1982).

Earthquakes of magnitude 3.5 and 4.4 (fig. 3 and table 2) and a diffuse pattern of microseismicity have been detected in Goshen Valley, about 10 km northwest of Mona Dam since installation of the University of Utah telemetered network in 1974. The activity appears to occur in temporal bursts including a magnitude 2.5 event and aftershocks in the vicinity of Mona Dam in May, 1979 (fig. 2) (McKee and Arabasz, 1982). These events do not appear to be associated with the known and inferred late Quaternary faults in the area. Fault plane solutions for seismicity in Goshen Valley all indicate normal faulting on possible fault planes striking northeast to northwest, but the tectonic significance of the activity has not been determined (McKee and Arabasz, 1982).

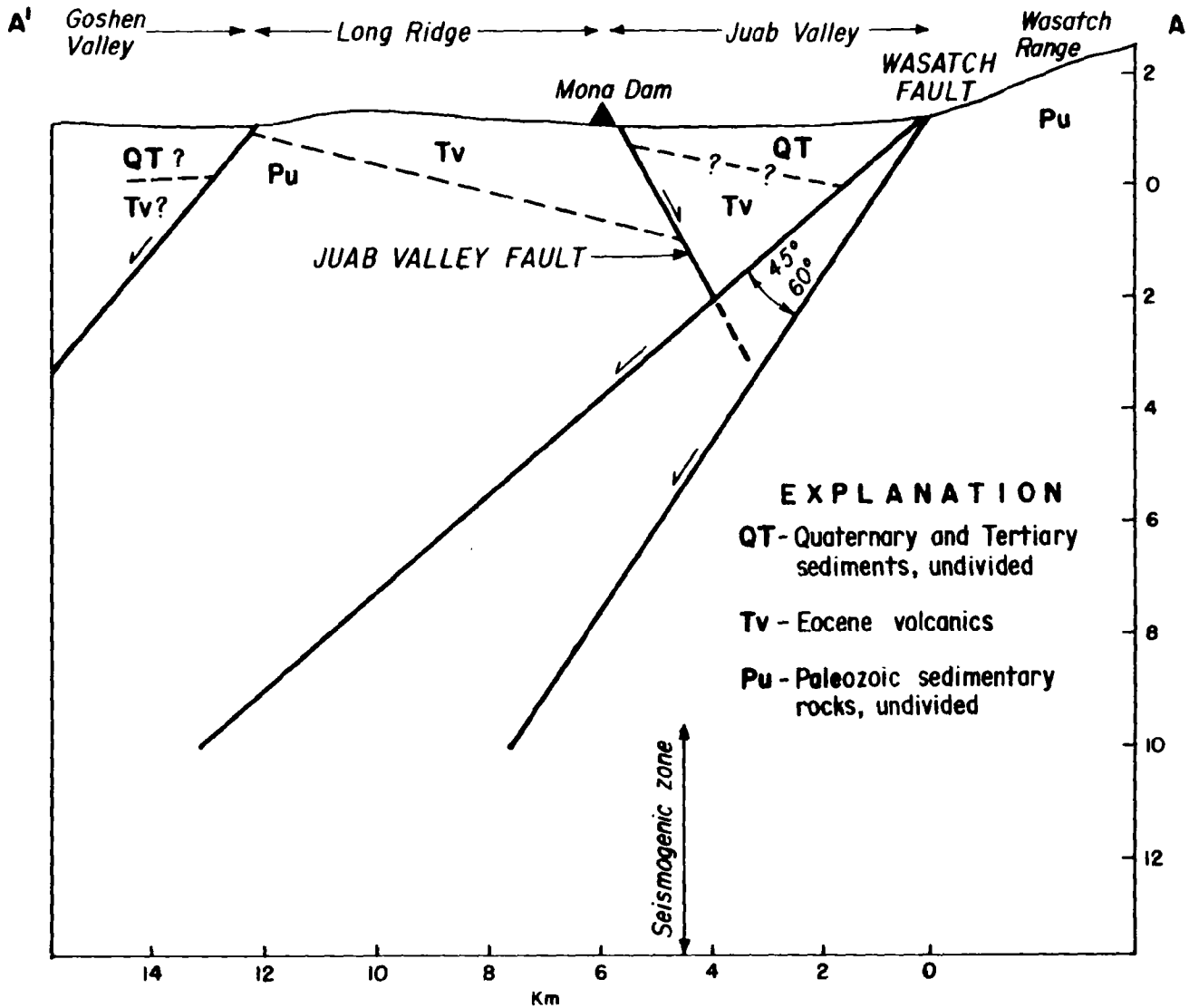

Figure 3. - East-West cross section through Mona Dam. A range of dips from 45° to 60° shown for Wasatch Fault. See Figure 2 for location.

3. SITE GEOLOGY

The proposed replacement dam will be built entirely on Tertiary volcanic rocks. On Long Ridge these rocks are called the Laguna Latite (Muessig, 1951) and consist largely of andesitic tuff breccia with minor zones of lapilli tuff and coarse tuff (USBR, 1986). The underlying Paleozoic sedimentary rocks are exposed about 2 km downstream of the dam (fig. 2). The Tertiary volcanics dip to the east on Long Ridge and reach a thickness of >90 m (300 ft) in the immediate vicinity of the dam (USBR, in prep). Details of the geology of the damsite are contained in U. S. Bureau of Reclamation site investigations reports (USBR, in prep.)

Northwest and north-northwest trending faults are exposed in the Paleozoic rocks on Long Ridge (not shown on fig. 2), but available mapping (Hintze, 1962; Davis, 1983) indicates that these faults do not displace the overlying Tertiary volcanics suggesting the faults are related to an earlier period of deformation. Widely-spaced, conspicuous joints are present in the abutments, but trenching, drilling and detailed mapping have revealed no faults or shear zones in the dam foundation (USBR, 1986, p. 20).

The inferred north-trending, late Quaternary normal fault on the east side of Long Ridge will cross the reservoir a few hundred meters upstream of the proposed dam.

4. MAXIMUM CREDIBLE EARTHQUAKES AND CONCLUSIONS

In this section we define source zones for moderate- and large-magnitude earthquakes in the vicinity of Mona damsite based on an interpretation of the geological and seismological evidence discussed above.

4.1 Relationship of seismicity and late Quaternary faulting

Fault scarps have formed during three historic earthquakes in the ISB - the 1934 Hansel Valley earthquake of M 6.6 (Shenon, 1936), the 1959 Hebgen Lake earthquake of M 7.5 (Myers and Hamilton, 1964) and the 1983 Borah Peak earthquake of M 7.3 (Crone and Machette, 1984). Important characteristics common to these events are significant to the future occurrence of other large-magnitude earthquakes in the Basin and Range. Doser (1985) concludes that in the ISB large-magnitude earthquakes nucleate at or near the base of the seismogenic zone (about 15 km) and rupture unilaterally to the surface along planar normal faults dipping 45° to 60° forming fault scarps on the updip projection of the causative faults. Geologic studies in the ISB and the Basin and Range have shown that historic surface ruptures have occurred on late Quaternary faults with a history of surface displacement events. Similar studies have identified other faults with no record of historic surface rupture but with geologic evidence of late Quaternary surface rupture that are considered potential sources of earthquakes.

Network monitoring, aftershock studies, and detailed microearthquake studies in the ISB indicate that small- and moderate- magnitude earthquakes show little or no spatial correlation with late Quaternary faults. Aftershock studies of recent moderate-magnitude earthquakes including the 1962 Cache Valley earthquake of M 5.7, the 1972 Heber earthquake of M 4.3, and the 1975 Pocatello Valley earthquake of M 6.0 have indicated that these events occurred at depths of 8 - 12 km on faults that can not be identified at the surface. Recent detailed microearthquake recording in the Basin and Range Transition zone in central Utah shows no correlation of earthquake activity with late Quaternary faults (McKee and Arabasz, 1982; Foley and others, 1986). These observations suggest that seismic slip manifested as background seismicity is occurring on moderate- to high-angle segments of blind faults that have no surface expression (Arabasz and Smith, 1981; Arabasz and Julander, 1986).

For hazard assessments, large-magnitude earthquakes associated with surface rupture and moderate- and small-magnitude background seismicity occurring on blind faults are considered as separate seismic sources. Doser (1985) has also suggested two models of earthquake occurrence in the ISB based on a compilation of surface rupture length, surface displacement, mainshock magnitude and focal depth, and geologic setting of historical earthquakes in both the ISB and the Nevada Basin and Range. She suggests that normal fault earthquakes are of two types: moderate-magnitude earthquakes (M 6 - 6 3/4) with fault lengths of 10 to 15 km, surface or geodetically determined displacements of 0.1 to 0.5 m, displacement on faults not necessarily associated with major fault systems, and a good possibility of foreshocks; and, large-magnitude earthquakes (M 7 - 7 1/2) with rupture lengths of 20 - 30 km (for surface displacement > 0.5 m, total length > 30 km), average surface displacement of 1-4 m along faults showing repeated late Quaternary surface displacements, and unilateral rupture nucleating at a depth that is

at or near the base of the seismogenic zone (15 km).

Both the late Quaternary geologic record and historic surface ruptures in the ISB and the Basin and Range indicate that large-magnitude earthquakes occur repeatedly on normal faults with an identifiable history of late Cenozoic surface displacements. It is this observation that forms the basis for identifying sources for large-magnitude earthquakes. These earthquakes vary in magnitude from 6 1/2 to 7 1/2 depending on fault length with differing magnitudes for individual faults. Identification of the faults which are the source of those earthquakes as well as their magnitudes, associated surface displacements, and return periods are based on geologic evidence from mapping and trenching studies.

A moderate-magnitude earthquake source, referred to as the random earthquake, that is not associated with late Quaternary surface faults, is identified in the ISB on the basis of contemporary small-and moderate-magnitude earthquake activity. This seismicity appears to be occurring on blind faults that lack expression at the surface. Although geodetically determined subsidence or small differential ground movements may occur in association with these background earthquakes, these are not surface ruptures in the previous sense. Rather, these ground movements are considered to be the result of secondary adjustments of upper crustal blocks to the subsurface displacement on the causative fault, as in the "shattered glass" model of Arabasz and Smith (1981).

4.2 Maximum Credible Earthquakes

Both seismologic and geologic studies indicate that the principal mode of deformation in the ISB is normal faulting in response to east-west crustal extension (Sullivan and others, 1986). The Maximum Credible Earthquakes (MCEs) discussed in this section are associated with generally north-trending normal faults and are assumed to be principally dip-slip earthquakes. The focal depth of these earthquakes is estimated to be 10 - 15 km.

4.2.1 Wasatch fault

The largest historical earthquakes in the ISB, the 1959 Hebgen Lake earthquake with a magnitude of 7.5 and the 1983 Borah Peak earthquake with a magnitude of 7.3 are considered to be representative of the maximum magnitude earthquake expected in the ISB (Doser, 1985). These earthquakes are associated with surface displacements of > 2 m and surface rupture lengths of > 20 km. In previous USBR studies MCE's of 7 1/2 have been estimated for late Quaternary faults in the ISB with surface rupture lengths and/or evidence of maximum individual surface displacements of >2 m (Gilbert and others, 1983; Piety and others, 1986; Foley and others, 1986; Sullivan and others, 1986). The detailed studies of the Wasatch fault summarized by Schwartz and Coppersmith (1984) have concluded that late Quaternary fault rupture lengths are 30 km or greater and maximum surface displacements are > 2 m. These studies have suggested that paleoearthquakes with magnitudes of 6 1/2 to 7 1/2 have occurred on the Wasatch fault during the Holocene. We concur with this interpretation and following previous practice assign an MCE of 7 1/2 to the Wasatch fault (table 1).

Although the surface trace of the Wasatch fault is within about 6 km of the

dam, the west dip of the fault places the zone of rupture beneath the damsite at a depth of 3 to 5 km depending on the dip of the fault (fig. 3).

4.2.2 Long Ridge

Air photos of the northern half of Long Ridge and the surrounding hills were reviewed for features that could be fault-related. A comparison was made between these features and a study of the fault scarps along the Wasatch Fault (Woodward-Lungren and Associates, 1973). No scarps or other lineaments were found in the immediate vicinity of Mona Dam and reservoir. However, several north-trending lineaments were found 7 - 8 km south of Mona Dam in alluvial fan deposits along the eastern margin of Long Ridge (fig. 2). These vegetation lineaments correspond with a steepening of the fan surface from 3° to 7° and vertical offset of the fan surface of about 1 m. A normal fault, the Juab Valley fault, has been inferred on the east side of Juab Valley and these offsets indicate that surface displacements have occurred on this fault during the late Quaternary. However, this fault appears to be antithetic to the west-dipping Wasatch fault for it must intersect the Wasatch fault at a depth well above seismogenic depths of large-magnitude earthquakes in the ISB (fig. 3). Therefore, this fault is not considered an independent source zone for large -magnitude earthquakes. The 1-m-high scarps on the Juab Valley fault are interpreted to have formed as sympathetic movement associated with a large-magnitude earthquake on the Wasatch fault.

A west-dipping normal fault has been inferred on the west margin of Long Ridge (Muessig, 1951) at or near the base of the bedrock escarpment formed in Paleozoic and Tertiary rocks on the east side of Goshen Valley (figs. 2 and 3). Our review of air photos revealed no scarps in late Quaternary deposits along this margin of the Long Ridge although small late Quaternary surface displacements at or near the base of the bedrock escarpment may not be discernable (e. g. Sullivan and others, 1986). The inferred surface trace of this fault is about the same distance from Mona Dam as the Wasatch fault, the fault dips away from the dam, and the maximum fault length is shorter than the Wasatch fault; therefore, earthquake effects from this fault, if it was determined to be a potential seismic source, are greatly overshadowed by those effects from the Wasatch fault and it is not discussed further in this report (Table 1).

4.2.3 Random earthquake

A random earthquake is considered a potential seismic source for all sites in the ISB (Sullivan and others, 1986). As the threshold for surface faulting in the ISB appears to be within the magnitude range 6 to 6 3/4, an MCE of magnitude 6 to 6 1/2 is assigned to this random earthquake source (Sullivan and others, 1986). Based on calculations of probabilistic epicentral distances from geologic and seismologic data, for annual probabilities of occurrence of 1/50 000 to 1/100 000, an earthquake of magnitude 6 or greater could occur within 5 km of any site (Sullivan and others, 1986). Therefore, the magnitude 6 to 6 1/2 random earthquake should be considered a local event that could occur in the immediate vicinity of Mona Dam.

Table 1 - Maximum Credible Earthquakes for Mona Dam

Earthquake Source	MCE (M_S)	Epicentral distance (km)	Focal depth (km)	Average Return Period (ka)
Wasatch fault	7 1/2	3-6*	10-15	1.7-3.0**
Random earthquake	6 to 6 1/2	local	8-15	N/A***

* closest approach of the surface trace is 5 to 6 km (fig. 2), actual distance from the zone of rupture is 3 to 5 km (fig. 3)

**Schwartz and Coppersmith (1984) for individual segments of the fault

***for an estimated annual probability of 0.00001 to 0.00002

4.3 Surface displacement in the dam foundation

USBR geologic investigations at the damsite have led to the conclusion that no faults or shear zones are present in the abutments or foundation of the dam (USBR, in prep.). Therefore we conclude that significant surface displacements in the foundation of the dam should not be considered in the design and analysis of the proposed dam. Joints have been identified in the abutments and in drill holes along the dam axis and it is possible that small adjustments on these pre-existing joints could occur in association with a large-magnitude earthquake on the Wasatch fault.

4.4 Geodetic effects and reservoir seiche

Significant geodetic effects are anticipated to accompany a large-magnitude earthquake on the Wasatch fault. These effects include sympathetic movement on the Juab Valley fault in the reservoir and additional tilt of the reservoir area resulting from subsidence of the hanging wall block of the Wasatch fault. Although the Juab Valley fault is not considered an independent seismic source (sec. 4.2.2), down-to-the-east vertical displacement on the fault of as much as 1 meter could occur in association with large-magnitude events on the Wasatch fault.

Subsidence of the hanging wall block and lesser amounts of uplift of the footwall have been observed in association with the Hebgen Lake (M 7.5) and Borah Peak (M 7.3) earthquakes (Stein and Barrientos, 1985). This hanging wall subsidence can also be expected to occur in the Mona Reservoir area in association with a large-magnitude earthquake on the Wasatch fault.

To estimate the reservoir tilt associated with this surface faulting, subsidence parameters for historical earthquakes of similar magnitude to the MCE on the Wasatch fault are compiled in table 2. Mona Dam is about 6 km west of the surface trace of the Wasatch fault (figs. 2 and 3). In table 2, at distances of 4 to 8 km from the surface rupture, topographic gradients of

Table 2 - Surface faulting parameters associated with selected historic earthquakes and estimates for the Wasatch fault.

EARTHQUAKE (date)	magnitude (Ms)	surface rupture length (km)	average vertical disp. (m)	max. vertical disp. (m)	[4] tilt (m/km)
[1] Borah Peak (1983)	7.3	34	0.8	2.7	0.1
[2] Hebgen Lake (1959)	7.5	30	4	6.7	0.6
[3] Pleasant Valley (1915)	7.7	59	2	5.8	n
Wasatch Fault (Nephi segment)	*7 1/2	**35	**2.0-2.6	n	***0.5

n not known
[1] from Crone and Machette (1984)
[2] from Myers and Hamiltom (1964) and Doser (1985)
[3] from Wallace (1984)
[4] estimated at a distance of 4 to 8 km from the surface rupture
* MCE
** from Schwartz and Coppersmith (1984)
*** estimated for MCE at 4 - 8 km from the Wasatch fault

subsidence (tilts) of 0.1 m/km and 0.6 m/km were observed for the Borah Peak and Hebgen Lake earthquakes. This gradient is related to the maximum and average values of surface displacement on the fault. Maximum values of surface displacement for the Wasatch fault are not known, but trenching has shown that vertical displacements of 2 to 2.6 m have occurred on the Nephi segment of the Wasatch fault in the last 4500 years (Schwartz and Coppersmith, 1984). This value is greater than the average displacement for the Borah Peak earthquake and less than the average displacement for the Hebgen Lake earthquake. Therefore, we have estimated tilt to be 0.5 m/km, slightly less than the 0.6 m/km associated with the Hebgen Lake earthquake and greater than the 0.1 m/km associated with the Borah Peak earthquake (table 2).

In figure 4 the combined effects of 1 m of sympathetic displacement on the Juab Valley fault and subsidence of the hanging wall block of the Wasatch fault have been estimated. The resulting reservoir surface profile in fig. 4b should be used in any analysis of seiche waves in the reservoir that may accompany the MCE on the Wasatch fault.

4.5 Reservoir-induced seismicity

Small- and moderate-magnitude earthquakes have resulted from the impounding of reservoirs. Large, deep reservoirs overlying young faults seem to be the most susceptible to reservoir-induced seismicity. Although young faults may be present in Mona Reservoir the height of the proposed dam (15 m) and the reservoir volume (19,000 acre-feet) are small. The proposed dam will impound a reservoir about the same size as the existing reservoir. This reservoir was first filled in the early 1900s and no reservoir-induced seismicity has been noted since that time. Therefore, we conclude that the possibility of future induced earthquakes occurring in Mona Reservoir is very remote. Further, based on the magnitudes of induced earthquakes from documented historical examples we conclude that if induced earthquakes were to occur their magnitudes would not exceed the MCEs proposed for the random earthquake or the Wasatch fault.

4.6 Further Studies

No further seismotectonic studies are recommended for Mona Dam.

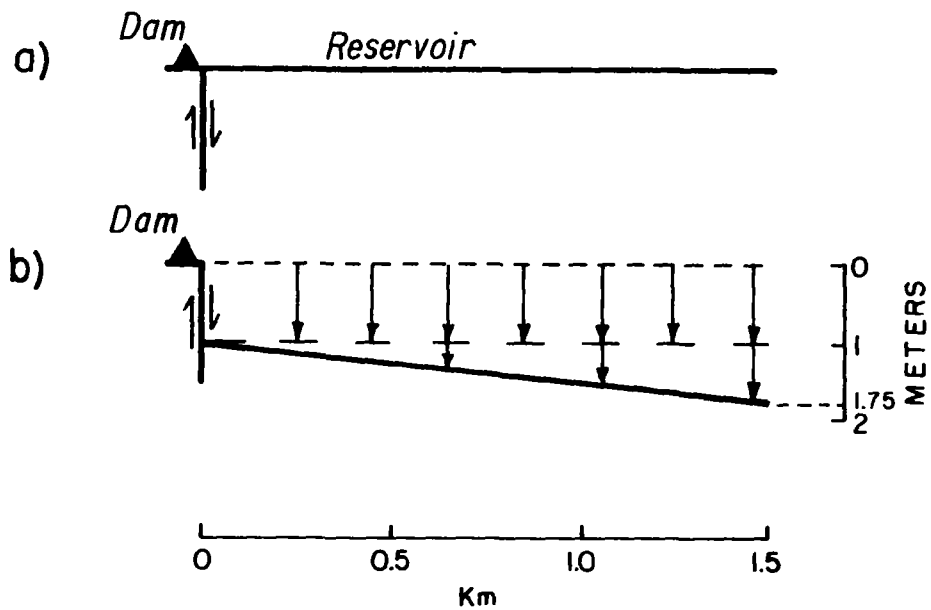

Figure 4.- Mona Reservoir surface profiles, a) before and b) after a hypothetical MCE of M $7\frac{1}{2}$ on the Wasatch fault. In b) upper arrows represent 1 m of displacement on the Juab Valley fault (figs. 2 and 3), lower arrows represent reservoir tilt (0.5 m/km at a distance of 4 to 8 km from the Wasatch fault), and the lower solid line represents the combined effects on the reservoir surface profile.

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The following errors have been noted since the reproduction of this report:

1) page 2, sec. 2.2, second line should read: .... eastside of Juab Valley about 6 km east of Mona Dam.....

2) page 5, line 1 should read: The Nephi segment of the Wasatch fault on the eastside of Juab Valley is the .....