H.H. Doelling and F.D. Davis THE GEOLOGY OF KANE COUNTY, UTAH

THE GEOLOGY OF KANE COUNTY, UTAH

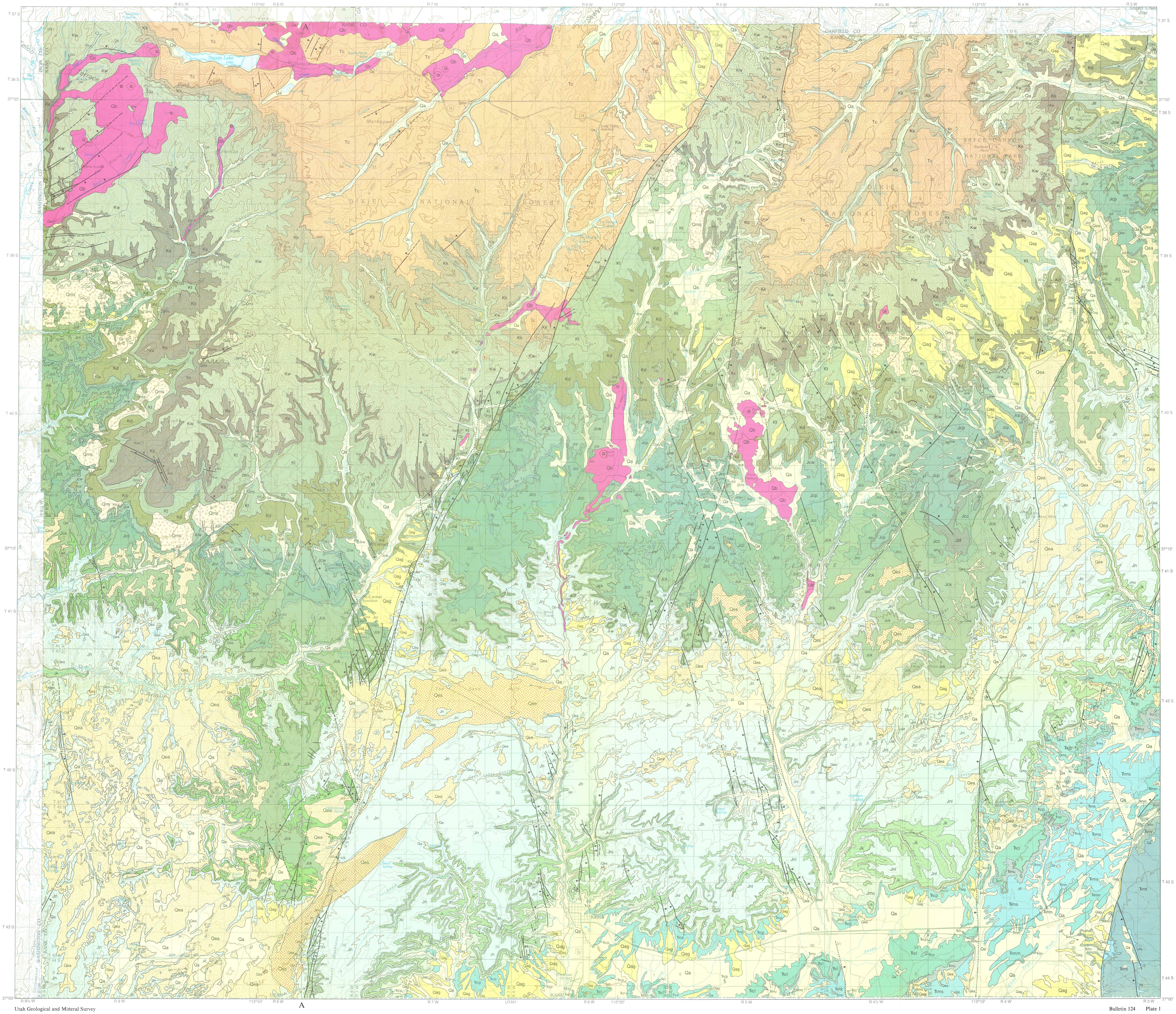
Geology
Mineral Resources
Geologic Hazards

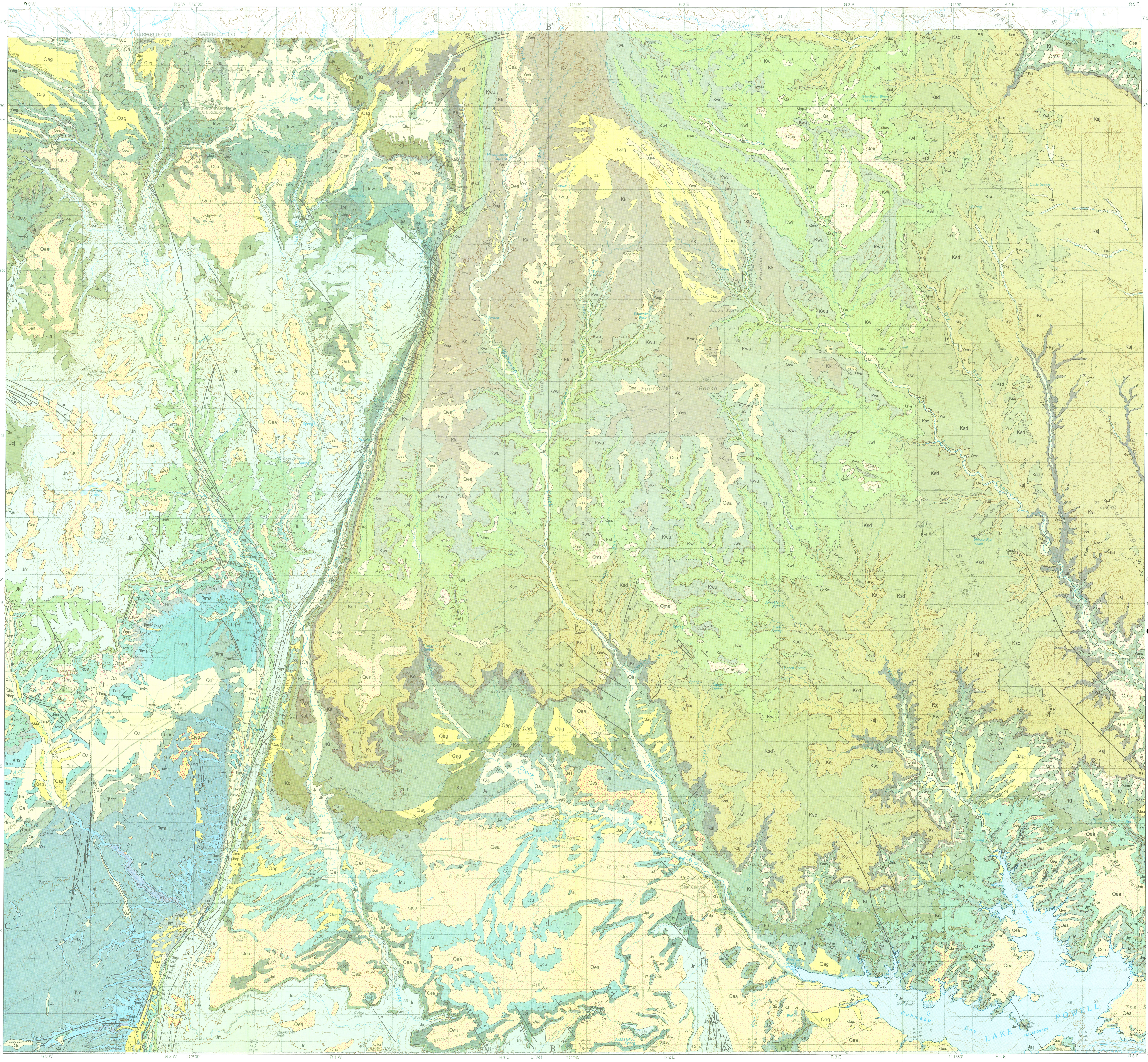
by

Hellmut H. Doelling and Fitzhugh D. Davis
with sections on petroleum and carbon dioxide
by
Cynthia J. Brandt

UTAH GEOLOGICAL AND MINERAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES
MAP 121 **1989**
To Accompany Bulletin 124

UGMS Map 121

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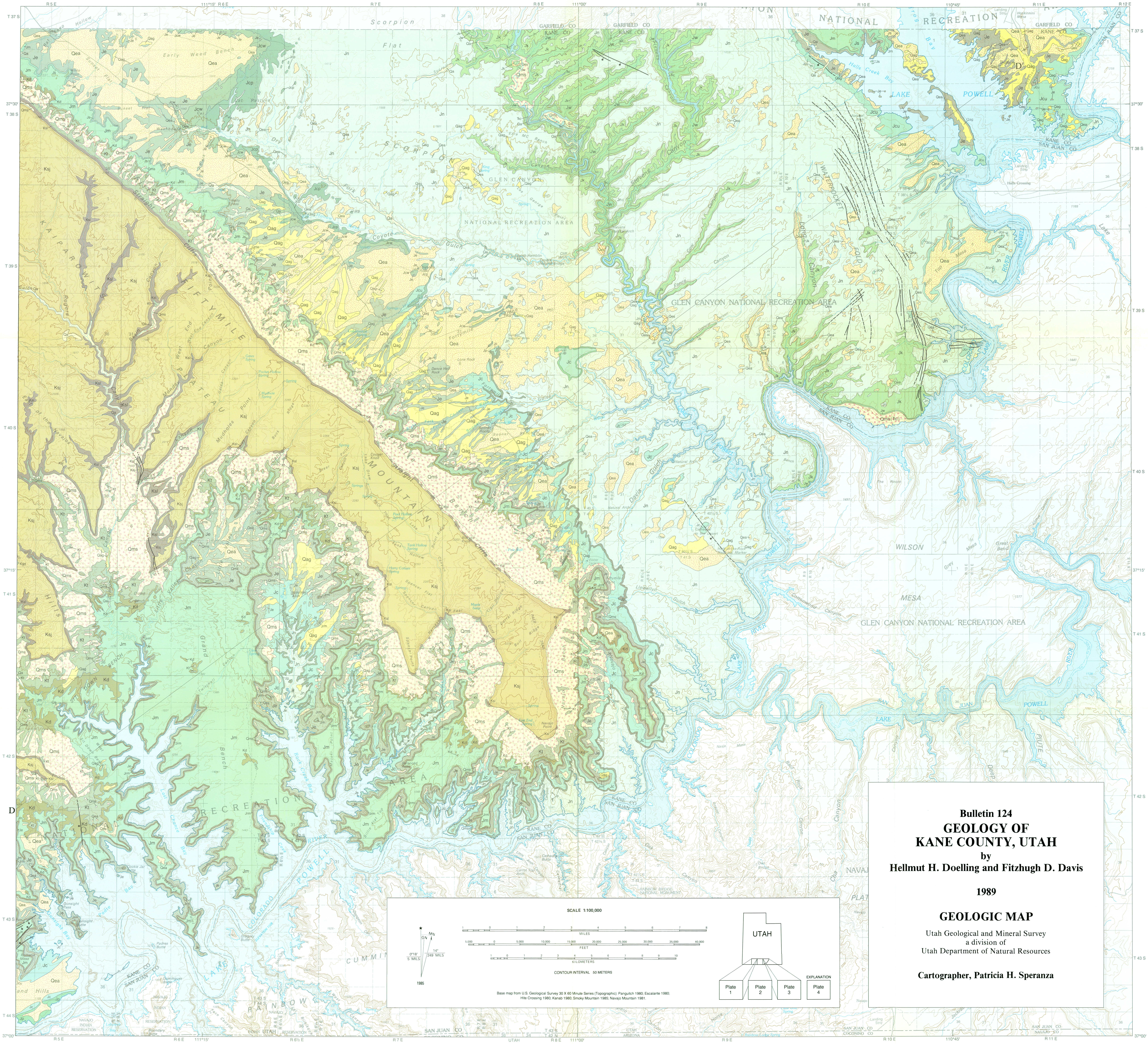
LAKE POWELL



Bulletin 124

GEOLOGY OF KANE COUNTY, UTAH

by

Hellmut H. Doelling and Fitzhugh D. Davis

1989

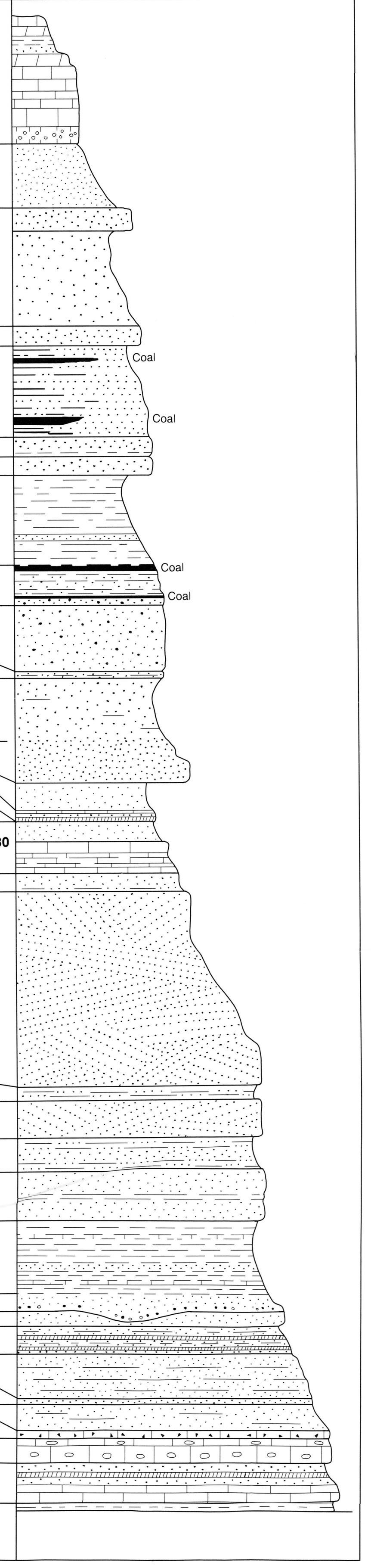
GEOLOGIC MAP

Utah Geological and Mineral Survey
a division of
Utah Department of Natural Resources

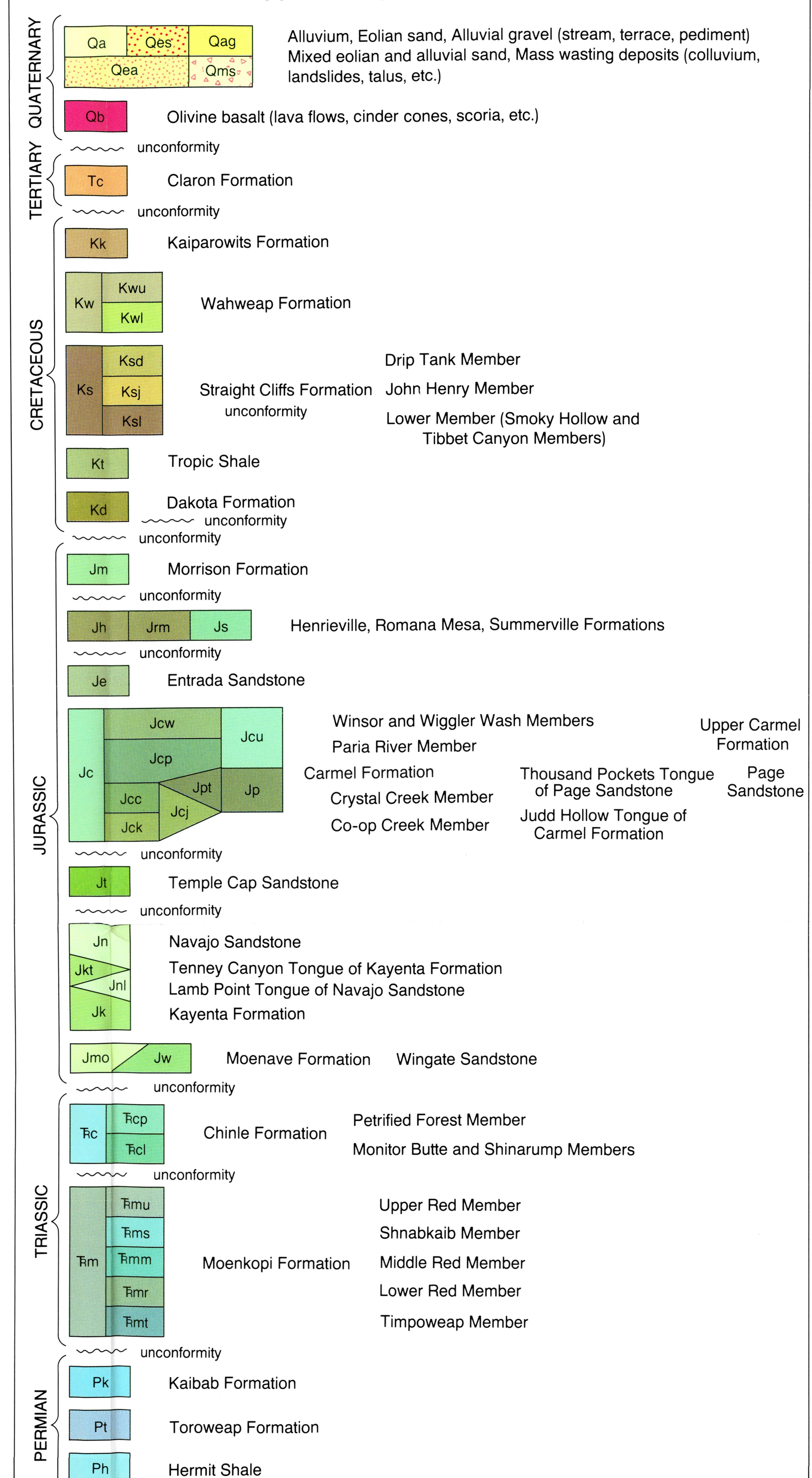
Cartographer, Patricia H. Speranza

FORMATION or MEMBER		MAP SYMBOL	THICKNESS IN FEET	
Claron Formation		Tc	1300+	
Kaiparowits Formation		Kk	400-2200	
Wahweap Formation		Kwu Kwl	400-1700	
Straight Cliffs Formation	Drip Tank Mbr	Ksd	85-1600	140-550
	John Henry Member	Ksj		590-1100
	Smoky Hollow Mbr.	Ksl		24-234
	Tibbet Canyon Mbr.			70-185
Tropic Shale		Kt	500-1000	
Dakota Formation		Kd	3-450	
Morrison Formation		Jm	0-700	
Hnrievl, Rom Mesa, Smrvl		Jh Jrm Js	0-234	
Entrada Sandstone	Escalante and Cannonville Members	Je	0-950+	0-560
	Lower 'Slickrim' Gunsight Butte			0-570
Carmel Formation	Winsor & Wiggler Wash	Jcw	100-700	0-350
	Paria River Mbr.	Jcp		50-230
	Thousand Pockets Page	Jpt Jp		0-200
	Crystal Creek / Judd Hollow	Jcc / Jcj		0-180 / 0-230
	Co-op Creek	Jck		0-250
Temple Cap Sandstone		Jt	0-150	
Navajo Sandstone		Jn	950-2000	
Tenney Canyon Tongue		Jkt	90-170	
Lamb Point Tongue		Jnl	90-410	
Kayenta Formation		Jk	190-340	
Moenave Formation or Wingate Sandstone		Jmo Jw	260-435 240-400	
Chinle Formation	Upper or Petrified Forest Member	Ŧcp	550-1000	500-900
	Lower or Shinarump	Ŧcl		0-155
Moenkopi Formation	Upper Red Mbr.	Ŧmu	±1035	±125
	Shnabkaib Mbr.	Ŧms		±220
	Middle Red Mbr.	Ŧmm		±370
	Virgin Limestone	Ŧmr		±30
	Lower Red Mbr.			±220
	Timpoweap Mbr.	Ŧmt		20-120
Kaibab Formation		Pk	0-500	
Toroweap-White Rim Coconino		Pt	260-450	
Hermit Shale Organ Rock		Ph	106-624	

LITHOLOGY



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qa Alluvium—*Mostly sand with lenses of silty clay, sandy silt, and gravel deposited in stream beds and adjacent floodplains, 0-120 feet.*

Qes Eolian sand—*Sand in active dunes and sheets, mostly fine to medium grained, mostly of quartz, 0-100 feet.*

Qea Mixed eolian and alluvial sand—*Mostly sand with minor amounts of clay, silt, or gravel, 0-100 feet.*

Qag Alluvial gravel—*Poorly to well-sorted gravel and sand with interlayers of silt and mud in pediments and river terraces, 0-60 feet.*

Qms Mass movements—*Includes rockfall, colluvium, talus, detrital masses, toreva blocks, landslides of all types, and landslide complexes, 0-250 feet.*

Qb Olivine basalt—*Blocky lava flows, cinder cones, scoria, bombs, lapilli, cinders, ash, and dust, flows to 60 feet, cones to 300 feet.*

Tc Claron Formation—*Upper part white limestone and dolomite, with subordinate yellow-gray, loosely cemented sandstone, tuffaceous sandstone, calcareous gray and reddish shales, and gray conglomerate; lower part mostly irregularly bedded pink or pink-stained limestone, mudstone, and conglomerate that weathers into cliffs and pinnacles usually overlying a basal conglomerate; total exposed unit is 1300+ feet.*

Kk Kaiparowits Formation—*Drab gray mostly slope-forming arkosic sandstone, 400-2200 feet.*

Wahweap Fm.

Kw Wahweap Formation—*Mostly gray to yellowish-gray interbedded mudstone, claystone, sandstone, siltstone and conglomerate; brown fine- to medium-grained sandstone; forms cliffs and ledges; not divisible west of the Kaiparowits Plateau, 400-1700 feet.*

Kwu Upper member—*Light gray, grayish orange, and yellowish-brown, fine- to medium-grained sandstone; forms cliffs and ledges; 150-800 feet.*

Kwl Lower member—*Interbedded yellowish-gray and yellowish-brown sandstone, shale, and siltstone; mostly slope former; 250-900 feet.*

Straight Cliffs Fm.

Ks Straight Cliffs Formation—*Yellow-gray, very fine to fine-grained, poorly sorted, medium- to thick-bedded, cliff-forming, calcareous sandstone interbedded with thin-bedded dark yellow-brown, less resistant sandstone and gray to brown shale or mudstone; the unit cannot be divided into members west of the Kaiparowits Plateau; 85-1600 feet.*

Ksd Drip Tank Member—*Yellow-gray and yellow-brown fine- to medium-grained, lenticular sandstone; 140-550 feet.*

Ksj John Henry Member—*Yellow-gray slope- and ledge-forming sandstone, mudstone, carbonaceous mudstone, and coal; contains the major coal resources of the Kaiparowits Plateau; 590-1100 feet.*

Ksl Lower Member—*Interbedded white and gray sandstone, mudstone, carbonaceous mudstone and coal (Smoky Hollow Member) 24-234 feet; underlain by yellowish gray to brown, cliff-forming sandstone (Tibbet Canyon Member) 70-185 feet.*

Kt Tropic Shale—*Dark gray, drab marine shale with subordinate gray sandstone; 500-1000+ feet.*

Kd Dakota Formation—*Interbedded sandy shale, carbonaceous shale, shaly sandstone, conglomerate and coal, contains the major coal resources of the Paunsaugunt and Markagunt Plateaus, basal conglomerate may be Lower Cretaceous in age; 3-450 feet.*

Jm Morrison Formation—*Gray, yellow, and brown cliff-forming lenticular conglomeratic sandstone and sandstone, subordinate green, gray or purple mudstone (Salt Wash Member); unit only exposed in eastern Kane County; 0-700 feet.*

Jh Henrieville Sandstone—*Upper part consists of white and yellowish-white horizontally bedded sandstone, shale, siltstone and claystone; forms steep slopes and cliffs; unit exposed only between Cannonville and Cottonwood Canyon; 0-234 feet.*

Jrm Romana Mesa Sandstone—*Grayish-yellow green, yellowish-gray, or light tan very fine- to fine-grained cliff-forming sandstone; unit is exposed only along the southeastern margins of the Kaiparowits Plateau; 0-145 feet.*

Js Summerville Formation—*Brown with some white alternating thin to medium even beds of siltstone, shale, mudstone, and fine-grained sandstone; cliff forming; exposed only in extreme eastern part of Kane County; about 145 feet.*

Je Entrada Sandstone—*Upper part (Escalante and Cannonville Members) is mostly reddish-brown, fine-grained sandstone; upper part is cliffy, lower part is non-resistant and often covered with sandy alluvium; earthy weathering and eolian facies; 0-560 feet; lower part (Gunsight Butte Member) is fine-grained sandstone forming smooth "slickrim" erosional forms and cliffs; orange-brown in north, yellowish gray in south; 0-570 feet. The Entrada Sandstone is missing in western exposures.*

Carmel Fm.

Jc Carmel Formation—*Earthy weathering sandstone and siltstone, limestone and shaly limestone, gypsum; 100-700 feet.*

Jcw Winsor and Wiggler Wash Members—*Reddish or yellow slope-forming and earthy weathering silty sandstone, 0-230 feet; between Cannonville and Cottonwood Canyon includes the overlying Wiggler Wash Member, reddish and lavender siltstone and earthy weathering sandstone, and gypsum, 0-75 feet.*

Jcp Paria River Member—*Gypsum, reddish siltstone and sandstone, with white chippy limestone at top, rests on Thousand Pockets Tongue of Page Sandstone in central Kane County and on Crystal Creek Member to west; 50-230 feet.*

Jcu Upper member—*Upper part mostly reddish or brown slope-forming and earthy weathering silty sandstone or siltstone intercalated with sporadic irregular beds of white calcareous fine-grained sandstone, locally gypsiferous, includes Wiggler Wash and Winsor Members of western sections, 60-150 feet; lower part mostly dark-reddish siltstone or silty sandstone with a few tan or brown fine-grained sandstone beds capped by silty or sandy white or pink, chippy weathering limestone (Paria River Member); 50-70 feet.*

Jpt Thousand Pockets Tongue—*Yellow, white or brown massive crossbedded sandstone, often with thin reddish siltstone intercalation, overlies Judd Hollow Tongue and Paria River Member of Carmel Formation in central Kane County; 0-250 feet.*

Jp Page Sandstone—*Mostly fine- to medium-grained, quartzose, crossbedded eolian sandstone; dark-reddish basal siltstone or silty sandstone locally present; unconformably overlies the similar-appearing Navajo Sandstone, present only in eastern part of Kane County; 30-250 feet.*

Jcc Crystal Creek Member—*Brown-banded earthy weathering sandstone; 0-180 feet.*

Jck Co-op Creek Member—*Thin- to medium-bedded light-gray limestone and tan limestone shale; 0-250 feet.*

Jcj Judd Hollow Tongue—*Interbedded sandstone, siltstone, and minor reddish and lavender limestone (Crystal Creek and Co-op Creek Members of western Kane County), exposed only along the southern part of the Cockscomb and as far east as Lake Powell; 0-230 feet.*

Jt Temple Cap Sandstone—*Light crossbedded cliff-forming sandstone with a few intercalations of dark-reddish siltstone (White Throne Member) and a prominent dark-reddish siltstone and silty sandstone at the base (Sinawava Member), unconformably underlies the Co-op Creek Member and unconformably overlies the Navajo Sandstone in western Kane County; 0-150 feet.*

Jn Navajo Sandstone—*White, pink, and brown, highly crossbedded sandstone that forms cliffs, domes and bare rock outcrops, excellent aquifer; 950-2000 feet.*

Jkt Tenney Canyon Tongue of Kayenta Formation—*Slope-forming reddish brown siltstone, mudstone, and fine-grained sandstone; 90-170 feet.*

Jnl Lamb Point Tongue of Navajo Sandstone—*White or light gray highly cross-bedded cliff-forming sandstone, excellent aquifer; 90-410 feet.*

Jk Kayenta Formation—*Ledge- and slope-forming lenticular sandstone, siltstone, limestone, and intraformational conglomerate. Mostly reddish, but lavender, white, and brown sandstones common; 190-340 feet.*

Jmo Moenave Formation—*Reddish flat-bedded fine-grained sandstone and siltstone, thin to thick cliff-forming beds, present only in west half of county; 260-435 feet.*

Jw Wingate Sandstone—*Reddish-orange or brown cliff-forming massive sandstone; present only in eastern Kane County; 240-400 feet.*

Chinle Fm.

Ŧcp Upper member (Petrified Forest Member)—*Varicolored, banded, slope-forming mudstone, claystone, sandstone, siltstone, limestone, and conglomerate, locally contains abundant petrified wood; 500-900 feet.*

Ŧcl Lower member (Monitor Butte and Shinarump Members)—*Conglomeratic sandstone, sandstone, mudstone; lenticular and cliffy; 0-155 feet.*

Moenkopi Fm.

Ŧmu Upper red member—*Dark brown fine-grained sandstone in thin to thick cliffy beds; about 125 feet.*

Ŧms Shnabkaib Member—*Light-brown and white earthy weathering sandstone, siltstone, and gypsum; about 220 feet.*

Ŧmm Middle red member—*Light reddish-brown, lightly banded, fine-grained gypsiferous and earthy weathering sandstone; about 370 feet.*

Ŧmr Lower red member—*Reddish fine-grained slope-forming sandstone and siltstone capped by 30 feet of tan, platy to thin-bedded, ledge-forming, calcareous sandstone (Virgin Limestone Member); about 250 feet.*

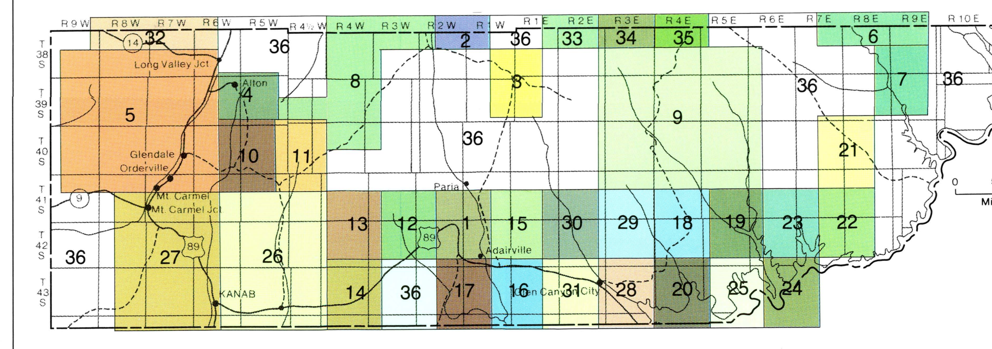
Ŧmt Timpoweap Member—*Hard limestone, sandstone, siltstone, chert breccia; 20-120 feet.*

Pk Kaibab Formation—*Thick to massive cliff-forming fossiliferous and cherty limestone. (Mostly subsurface); 0-500 feet.*

Pt Toroweap Formation—*Cyclic limestone, dolomite, anhydrite and gypsum, and sandstone (mostly subsurface), in the subsurface includes Coconino and White Rim Sandstones; 260-450 feet.*

Ph Hermit Formation-Organ Rock Shale—*Reddish-brown silty sandstone (mostly subsurface); 106-624 feet.*

GEOLOGIC MAP SOURCES



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21. Peterson, Fred, 1975, Geologic map of the Sooner Bench quadrangle, Kane County, Utah: U. S. Geological Survey Map I-874.
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24. Peterson, Fred, and Barnum, B. E., 1973c, Geologic map of the southwest quarter of the Cummings Mesa quadrangle, Kane and San Juan Counties, Utah, and Coconino County, Arizona: U. S. Geological Survey Map I-759.
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29. Waldrop, H. A., and Sutton, R. L., 1967a, Preliminary geologic map and coal deposits of the northeast quarter of the Nipple Butte quadrangle, Kane County, Utah: Utah Geological and Mineral Survey Map 24-B.
30. Waldrop, H. A., and Sutton, R. L., 1967b, Preliminary geologic map and coal deposits of the northwest quarter of the Nipple Butte quadrangle, Kane County, Utah: Utah Geological and Mineral Survey Map 24-A.
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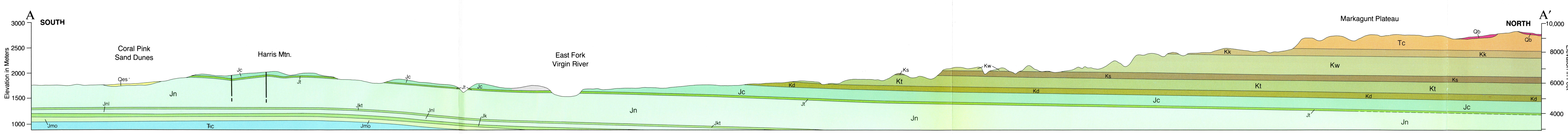
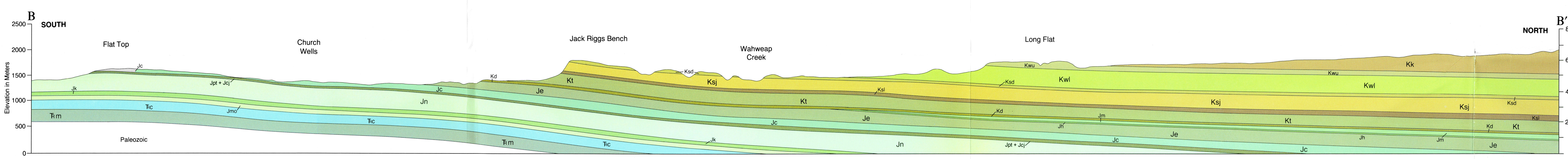
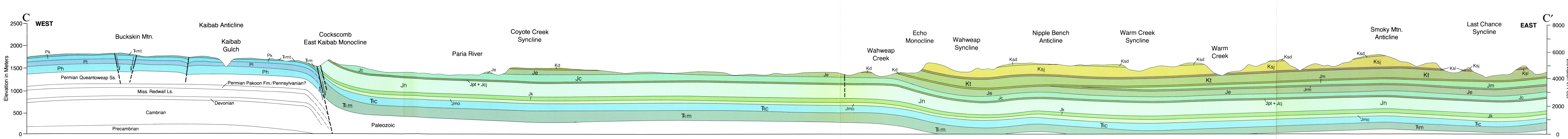
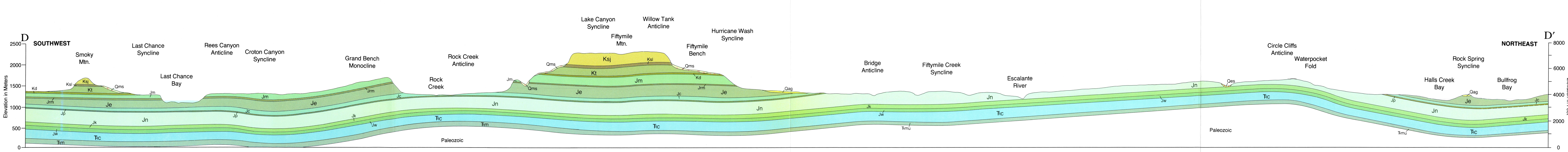
36. Unpublished mapping by compilers.









All cross sections; horizontal scale 1:100,000, vertical exaggeration approximately 2.2X, thinner units further exaggerated.

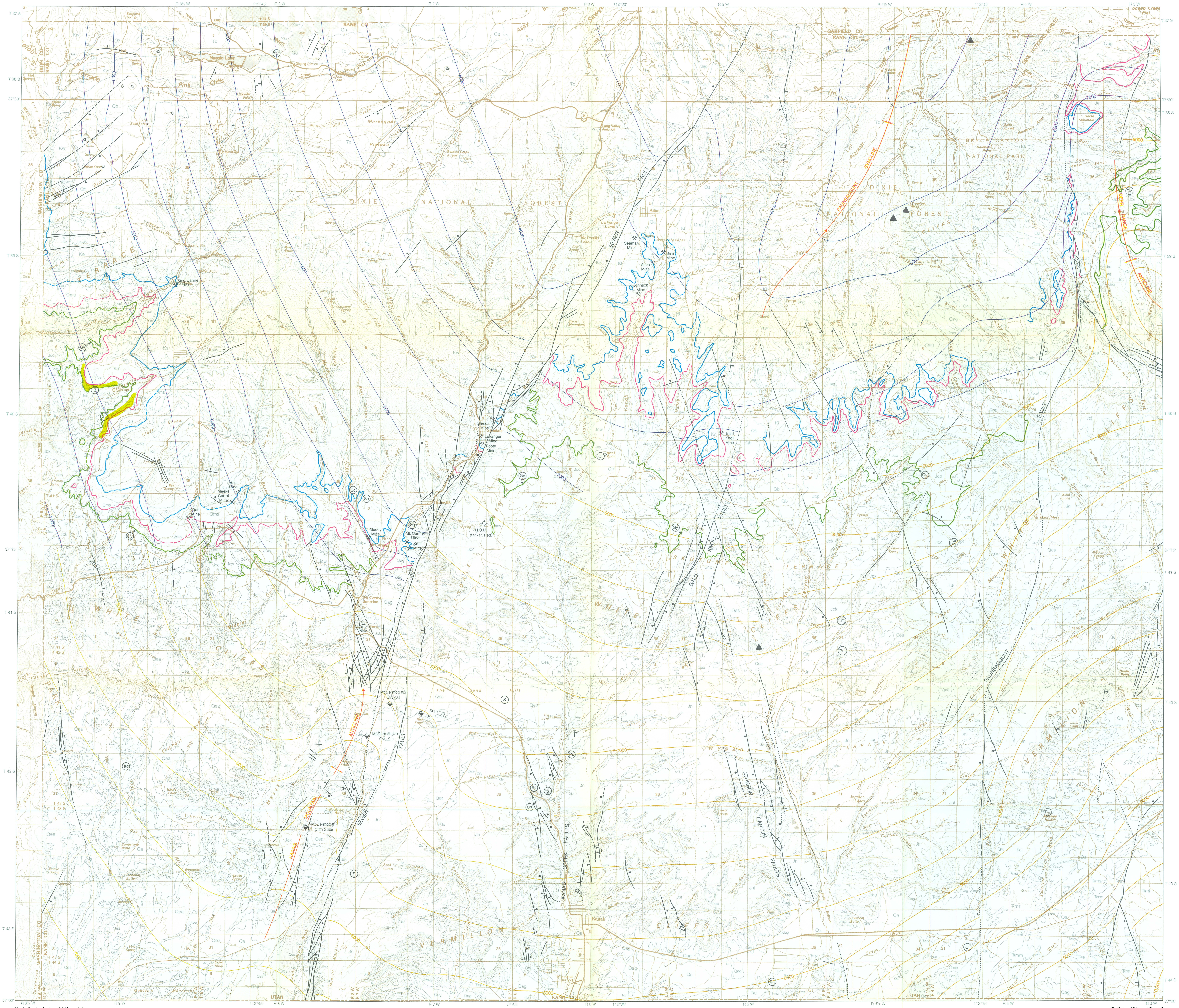
MAP SYMBOLS

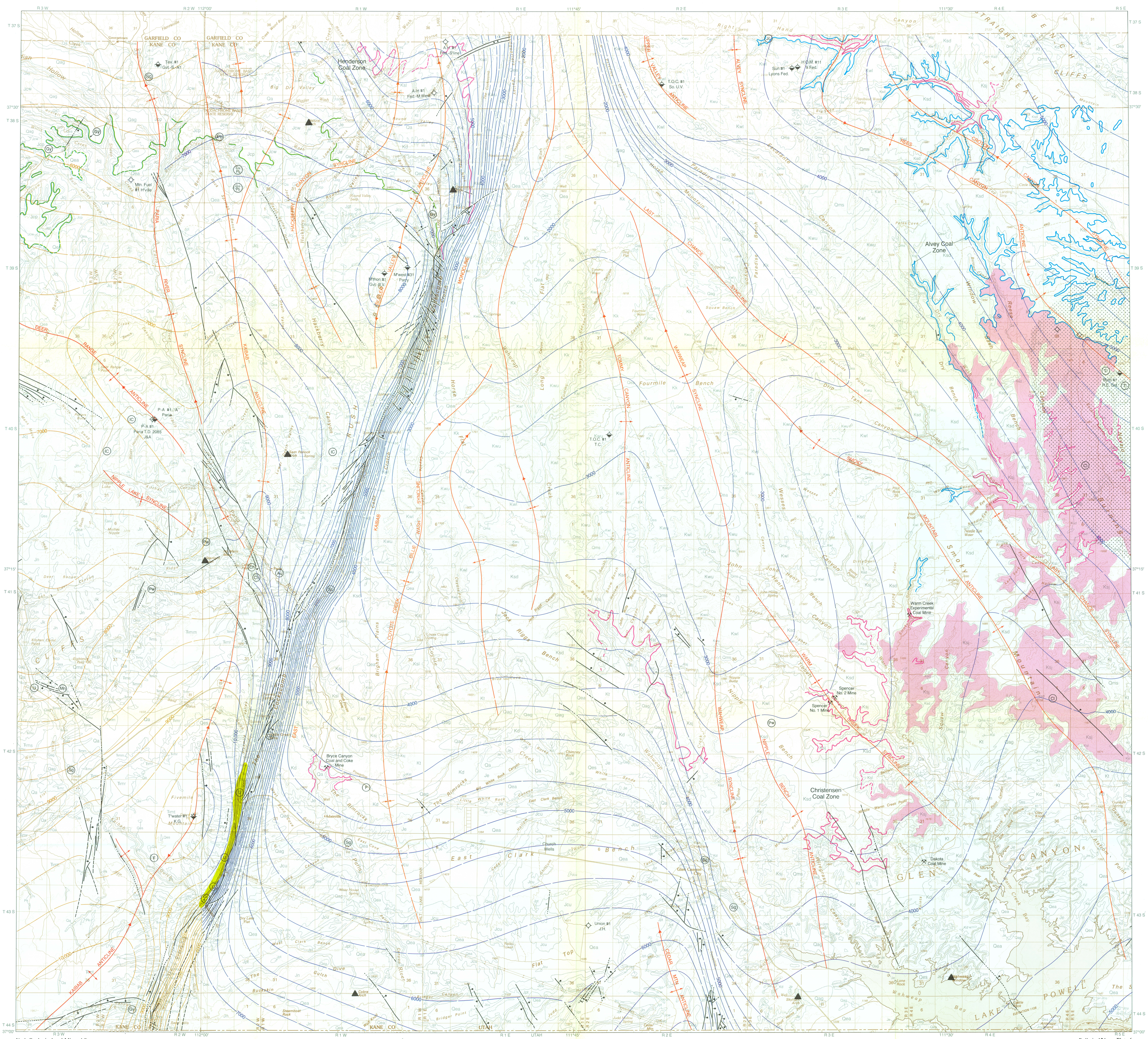
CONTACT
Dashed where inferred

FAULT
Dashed where inferred; dotted where covered; bar and ball on downthrown side

BASALTIC CINDER CONE

Arrows show direction of movement


DIXIE NATIONAL FOREST
BRYCE CANYON NATIONAL PARK
GARFIELD CO
KANE CO
SEVIER FAULT
BALD KNOLL FAULT
JOHNSON CANYON FAULTS
KANAB CREEK FAULTS
PAUNSAUGUNT FAULT
PINK CLIFFS
WHITE CLIFFS
VERMILION CLIFFS
TERRACE
Kanab
Mt. Carmel
UTAH
ARIZONA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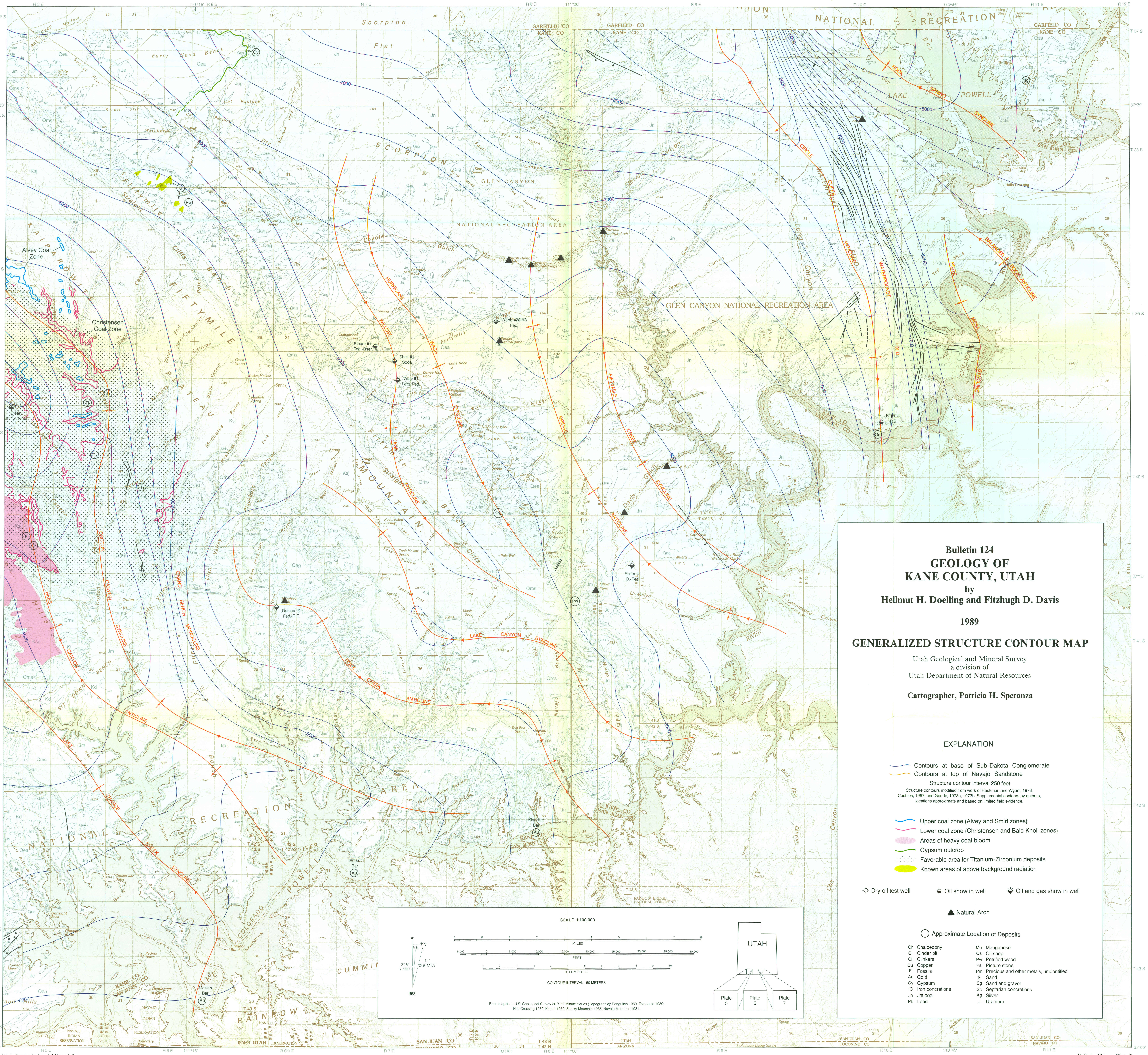
37°30'
37°15'
37°00'
112°00'
111°45'
111°30'
GARFIELD CO
KANE CO
UTAH
Henderson Coal Zone
Alvey Coal Zone
Christensen Coal Zone
Warm Creek Experimental Coal Mine
Spencer No. 2 Mine
Spencer No. 1 Mine
Bryce Canyon Coal and Coke Mine
Dakota Coal Mine
Church Wells
Union #1 J.H.
T.O.C. #1 T.C.
T.O.C. #1 So. U.V.
P-A #1 Paria
Tex. #1 Gvt.-S.-A1
Mtn. Fuel #1 H'ville
STRAIGHT CLIFFS
Fourmile Bench
East Clark Bench
Jack Riggs Bench
GLEN CANYON
LAKE POWELL
Smoky Mountain
PARIA RIVER SYNCLINE
KAIBAB ANTICLINE
EAST KAIBAB MONOCLINE
TOMMY CANYON ANTICLINE
WAHWEAP SYNCLINE
NIPPLE BENCH ANTICLINE
CEDAR MTN ANTICLINE
SMOKY MOUNTAIN ANTICLINE
LAST CHANCE SYNCLINE
UPPER VALLEY ANTICLINE
DEER RANGE ANTICLINE
NIPPLE LAKE SYNCLINE



Bulletin 124

GEOLOGY OF KANE COUNTY, UTAH

by

Hellmut H. Doelling and Fitzhugh D. Davis

1989

GENERALIZED STRUCTURE CONTOUR MAP

Utah Geological and Mineral Survey
a division of
Utah Department of Natural Resources

Cartographer, Patricia H. Speranza

EXPLANATION

Contours at base of Sub-Dakota Conglomerate
Contours at top of Navajo Sandstone

Structure contour interval 250 feet

Structure contours modified from work of Hackman and Wyant, 1973, Cashion, 1967, and Goode, 1973a, 1973b. Supplemental contours by authors, locations approximate and based on limited field evidence.

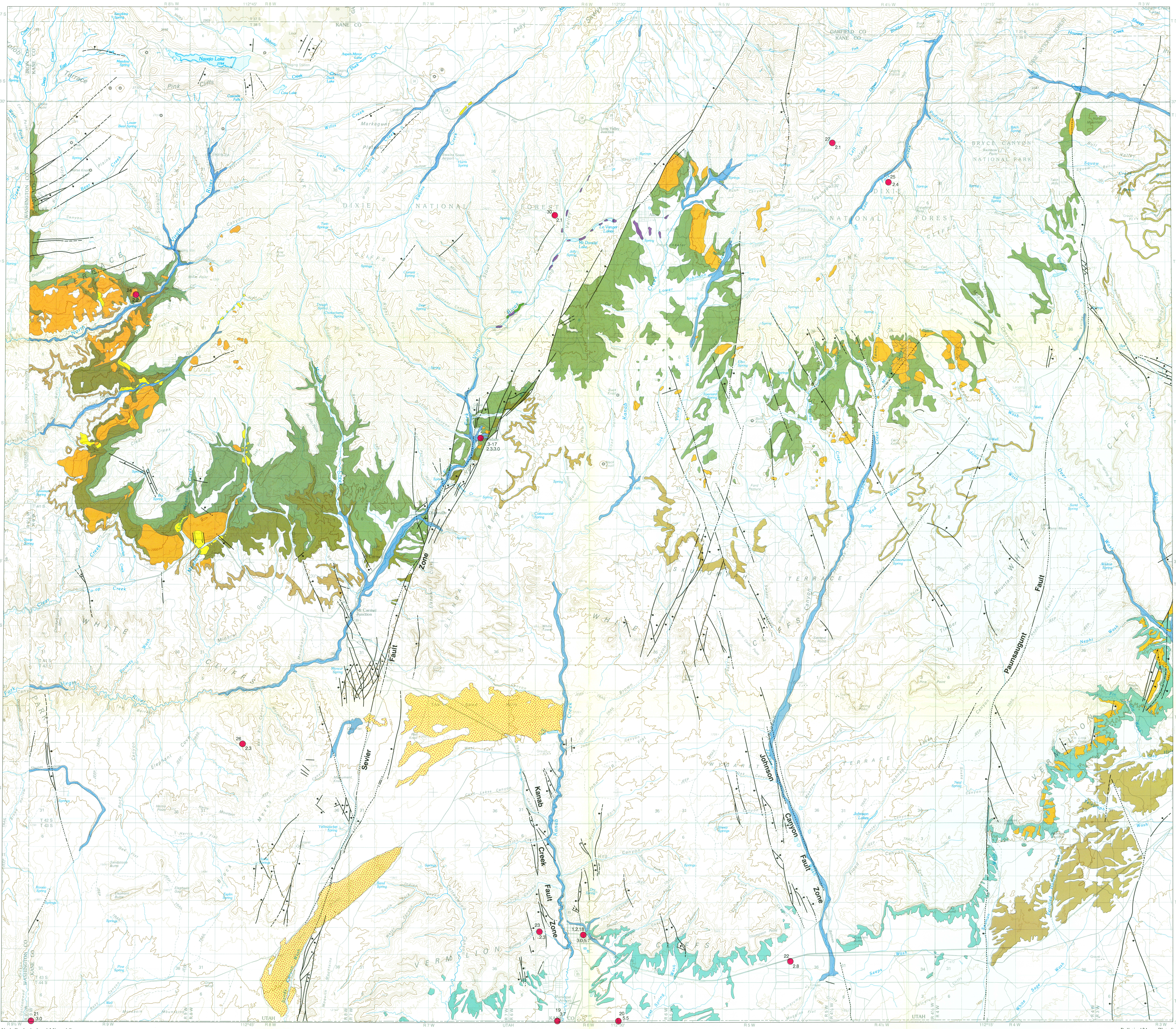
Upper coal zone (Alvey and Smirl zones)
Lower coal zone (Christensen and Bald Knoll zones)
Areas of heavy coal bloom
Gypsum outcrop
Favorable area for Titanium-Zirconium deposits
Known areas of above background radiation

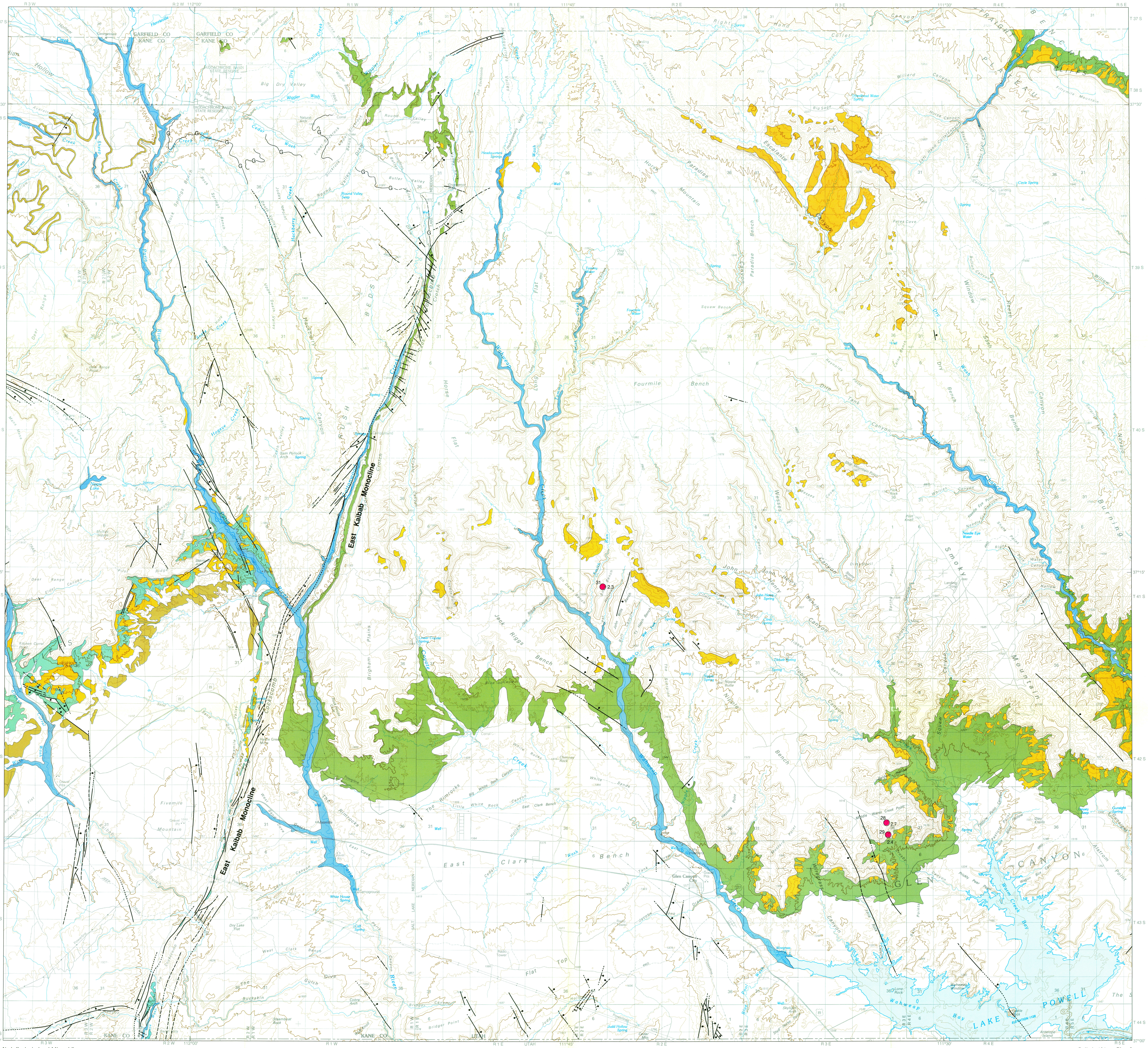
Dry oil test well
Oil show in well
Oil and gas show in well

Natural Arch

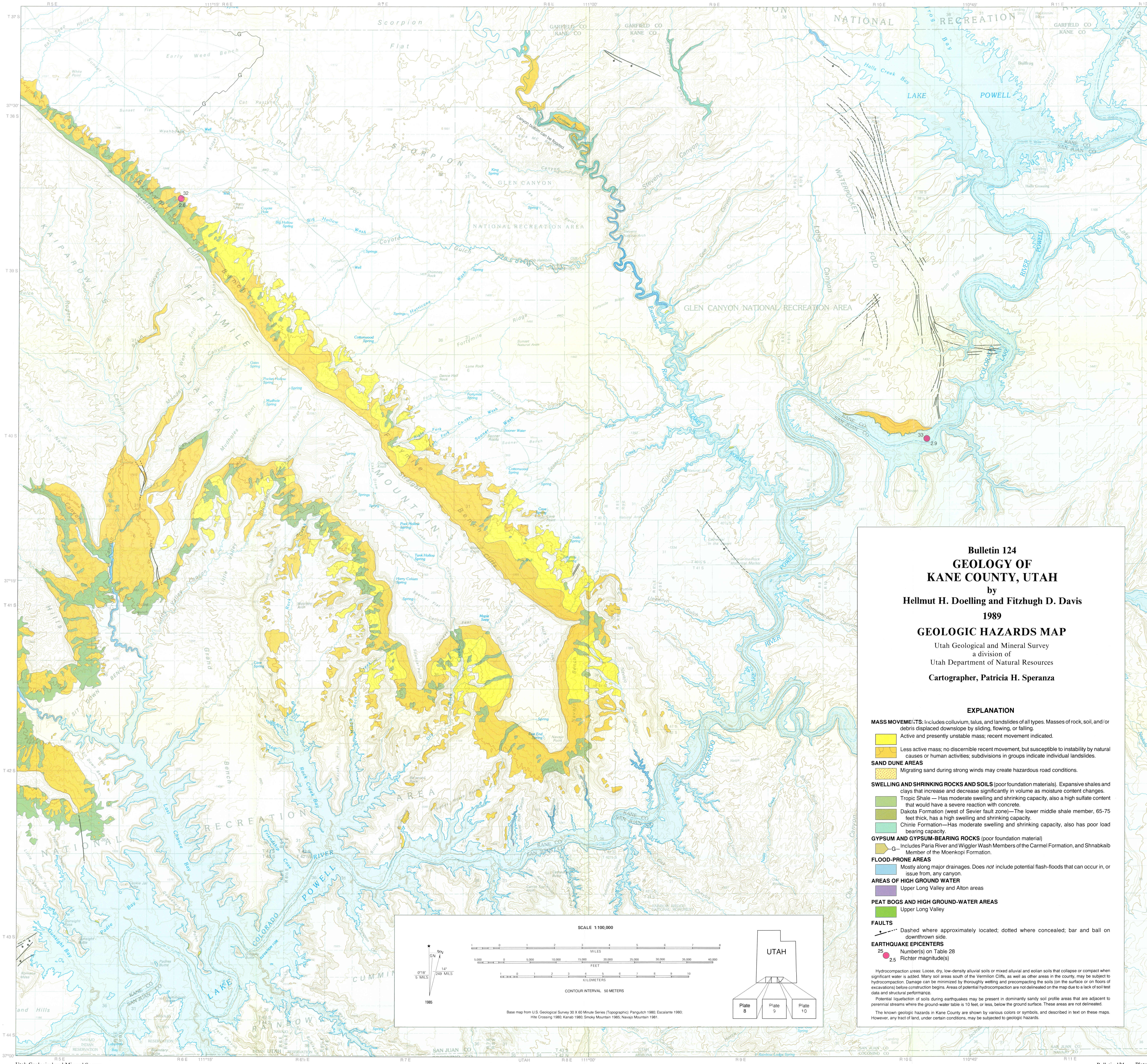
Approximate Location of Deposits

Ch	Chalcedony	Mn	Manganese
Ci	Cinder pit	Os	Oil seep
Cl	Clinkers	Pw	Petrified wood
Cu	Copper	Ps	Picture stone
F	Fossils	Pm	Precious and other metals, unidentified
Au	Gold	S	Sand
Gy	Gypsum	Sg	Sand and gravel
IC	Iron concretions	Sc	Septarian concretions
Jc	Jet coal	Ag	Silver
Pb	Lead	U	Uranium


Sevier Fault Zone
Kanab Creek Fault Zone
Johnson Canyon Fault Zone
Paunsaugunt Fault
DIXIE NATIONAL FOREST
BRYCE CANYON NATIONAL PARK
Navajo Lake
KANE CO
GARFIELD CO
UTAH



East Kaibab Monocline
East Kaibab Monocline
Jack Riggs Bench
Fourmile Bench
Smoky Mountain
East Clark Bench
Flat Top
LAKE POWELL
GLEN CANYON
Glen Canyon City
The Rimrocks
Fivemile Mountain
Brigham Plains
Wahweap Bay
Warm Creek Bay
GARFIELD CO
KANE CO



Bulletin 124

GEOLOGY OF KANE COUNTY, UTAH

by
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1989

GEOLOGIC HAZARDS MAP

Utah Geological and Mineral Survey
a division of
Utah Department of Natural Resources

Cartographer, Patricia H. Speranza

EXPLANATION

MASS MOVEMENTS: Includes colluvium, talus, and landslides of all types. Masses of rock, soil, and/or debris displaced downslope by sliding, flowing, or falling.

- Active and presently unstable mass; recent movement indicated.
- Less active mass; no discernible recent movement, but susceptible to instability by natural causes or human activities; subdivisions in groups indicate individual landslides.

SAND DUNE AREAS

- Migrating sand during strong winds may create hazardous road conditions.

SWELLING AND SHRINKING ROCKS AND SOILS (poor foundation materials). Expansive shales and clays that increase and decrease significantly in volume as moisture content changes.

- Tropic Shale — Has moderate swelling and shrinking capacity, also a high sulfate content that would have a severe reaction with concrete.
- Dakota Formation (west of Sevier fault zone)—The lower middle shale member, 65-75 feet thick, has a high swelling and shrinking capacity.
- Chinle Formation—Has moderate swelling and shrinking capacity, also has poor load bearing capacity.

GYPSUM AND GYPSUM-BEARING ROCKS (poor foundation material)

- –G– Includes Paria River and Wiggler Wash Members of the Carmel Formation, and Shnabkaib Member of the Moenkopi Formation.

FLOOD-PRONE AREAS

- Mostly along major drainages. Does *not* include potential flash-floods that can occur in, or issue from, any canyon.

AREAS OF HIGH GROUND WATER

- Upper Long Valley and Alton areas

PEAT BOGS AND HIGH GROUND-WATER AREAS

- Upper Long Valley

FAULTS

- Dashed where approximately located; dotted where concealed; bar and ball on downthrown side.

EARTHQUAKE EPICENTERS

- 25 Number(s) on Table 28
- 2.5 Richter magnitude(s)

Hydrocompaction areas: Loose, dry, low-density alluvial soils or mixed alluvial and eolian soils that collapse or compact when significant water is added. Many soil areas south of the Vermilion Cliffs, as well as other areas in the county, may be subject to hydrocompaction. Damage can be minimized by thoroughly wetting and precompacting the soils (on the surface or on floors of excavations) before construction begins. Areas of potential hydrocompaction are not delineated on the map due to a lack of soil test data and structural performance.

Potential liquefaction of soils during earthquakes may be present in dominantly sandy soil profile areas that are adjacent to perennial streams where the ground-water table is 10 feet, or less, below the ground surface. These areas are not delineated.

The known geologic hazards in Kane County are shown by various colors or symbols, and described in text on these maps. However, any tract of land, under certain conditions, may be subjected to geologic hazards.