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Preliminary report on and measured sections of the Middle Jurassic Entrada Sandstone and Wanakah Formation near Placerville, southwestern Colorado

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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PRELIMINARY REPORT ON AND MEASURED SECTIONS OF THE MIDDLE JURASSIC ENTRADA SANDSTONE AND WANAKAH FORMATION NEAR PLACERVILLE, SOUTHWESTERN COLORADO

By Brenda A. Steele

INTRODUCTION

The Middle Jurassic Entrada Sandstone contains an unusual type of vanadium-uranium-chromium mineralization in the vicinity of Placerville, southwestern Colorado (fig. 1). Most sandstone-hosted vanadium-uranium deposits are found in fluvio-lacustrine rocks (Finch, 1967), whereas the Entrada deposits occur in eolian rocks. Hess (1913), Fischer (1937, 1955, and 1968), and Fischer and others (1947) did the early work on the Entrada vanadium-uranium-chromium deposits; however little work has been done on them in recent years. Part of the key to understanding the Entrada mineralization is a better knowledge of the Entrada Sandstone's depositional setting in southwestern Colorado and the stratigraphic relationships of the Entrada to other Jurassic units in the region. The purpose of my study is to examine the sedimentology, petrology, and stratigraphy of the Entrada Sandstone in southwestern Colorado. In addition to the Entrada, the overlying Jurassic Wanakah Formation, Junction Creek Sandstone, and lowermost part of the Salt Wash Member of the Morrison Formation are also being examined. All of these Jurassic-age units may constitute a single depositional sequence, and thus must be studied together.

This report contains brief discussions of preliminary findings from the study, and graphic representations of 11 measured stratigraphic sections (appendicies 1-11). All data used in this report were collected during the 1983 and 1984 field seasons. Assisting me in the field were Lori Tagawa, Larry Gibson, Melisa Fry, John Stanesco, and Mark Larson.

GEOLOGIC SETTING

The study area is located in the southwestern portion of Colorado (fig. 1), an area with a complex geologic setting. Rocks from Precambrian to Tertiary age are exposed in this region. Paleozoic, Mesozoic, and Cenozoic rocks in this area have been folded and faulted through time, and have been intruded by numerous stocks, sills and dikes related to tectonic activity during the Laramide orogeny. Southwestern Colorado is also rich in mineral deposits of base, precious, and rare metals. A detailed examination of the geology of the Placerville area was made by Bush and others (1959, 1960); and Larsen and Cross (1956), Kent and Porter (1980), and Baars and Ellingson (1984) gave good discussions of the general geology of southwestern Colorado.

METHODS

Eleven sections of the Entrada Sandstone and related units were measured and sampled (table 1). Most of the sections are in the vicinity of Placerville, but some are also in surrounding areas (fig. 1). Access to the Entrada in many areas is limited, due to the Entrada's tendency to form steep cliffs, but an attempt was made to examine both mineralized and nonmineralized

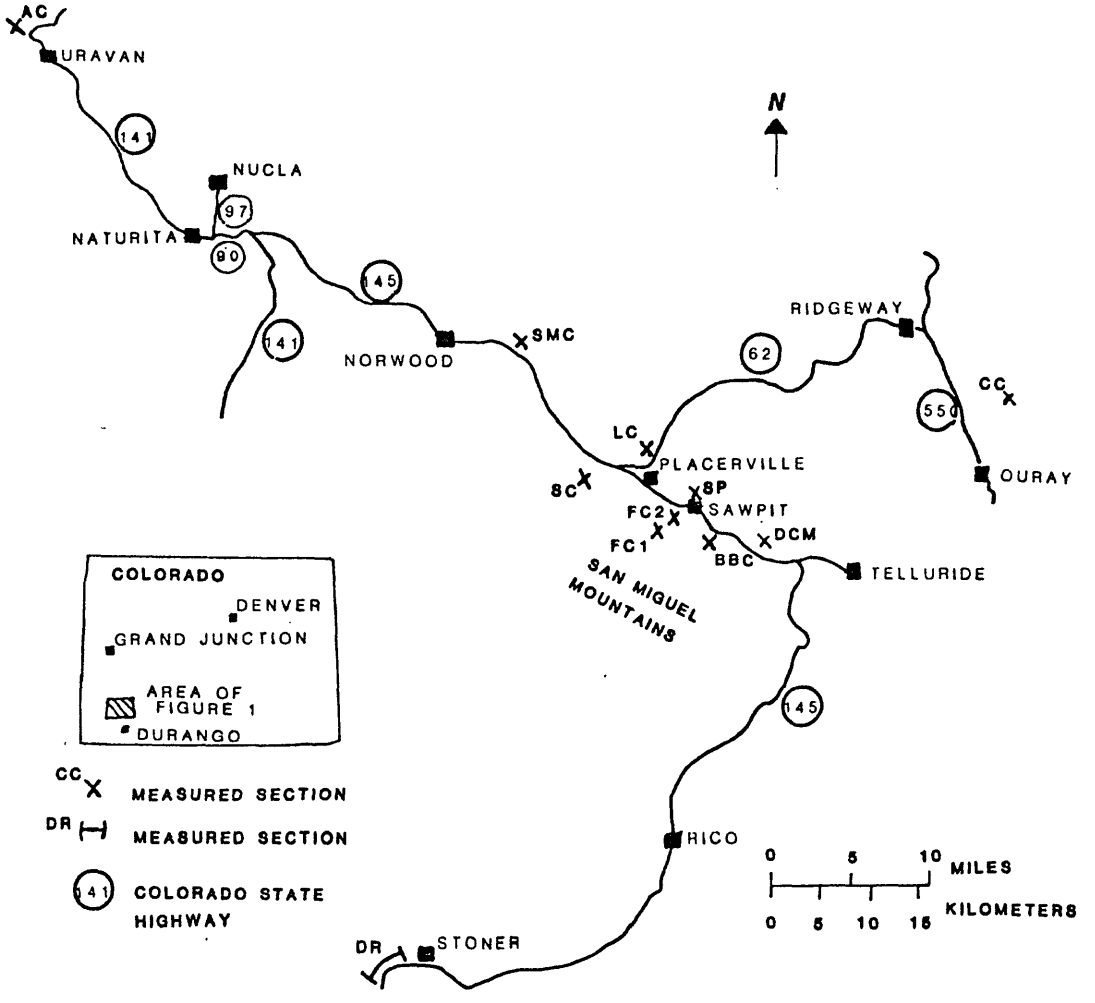

Figure 1--Index map of study area, showing locations of measured sections. (See table 1 for specific measured section locations.)

TABLE 1.-- Location of measured sections.

Section	Location
Atkinson Creek (AC)	NW 1/4, NW 1/4, Sec. 28, T. 48 N., R. 17 W.
Big Bear Creek (BBC)	NE 1/4, SW 1/4, Sec. 33, T. 43 N., R. 10 W.
Cutler Creek (CC)	SW 1/4, SE 1/4, Sec. 1, T. 44 N., R. 8 W.
Deep Creek Mesa (DCM)	NE 1/4, NW 1/4, Sec. 6, T. 43 N., R. 10 W.
Dolores River (DR)	
Entrada Sandstone-	
Lower Wanakah Formation	NW 1/4, NE 1/4, Sec. 6, T. 38 N., R. 13 W.
Upper Wanakah Formation	NW 1/4, SE 1/4, Sec. 2, T. 38 N., R. 14 W.
Junction Creek Sandstone	NE 1/4, NW 1/4, Sec. 11, T. 38 N., R. 14 W.
Fall Creek 1 (FC1)	SW 1/4, NW 1/4, Sec. 25, T. 43 N., R. 11 W.
Fall Creek 2 (FC2)	NW 1/4, SW 1/4, Sec. 18, T. 43 N., R. 10 W.
Leopard Creek (LC)	NW 1/4, NW 1/4, Sec. 24, T. 44 N., R. 11 W.
San Miguel Canyon (SMC)	SE 1/4, SW 1/4, Sec. 3, T. 44 N., R. 12 W.
Sawpit (SP)	NW 1/4, SW 1/4, Sec. 6, T. 43 N., R. 10 W.
Specie Creek (SC)	SE 1/4, NW 1/4, Sec. 6, T. 43 N., R. 11 W.

Entrada where possible.

All sections were measured with a Jacob's staff, and care was taken to accurately describe type, size, and when possible orientation of sedimentary structures; contact relationships; vertical changes within each section; and lateral changes between sections. Measured section data were recorded on standardized stratigraphic description forms (Reynolds and others, 1975); appendicies 1-11 contain the description forms for each section.

Samples for petrographic analysis were taken at regular intervals, where possible, throughout each section; in many places extensive cementation of the Entrada made sampling difficult. Samples were also taken for heavy mineral and clay ananlyses from a mineralized area, Leopard Creek, and a nonmineralized area, San Miguel Canyon (fig. 1). All sample locations are marked on the section description forms (appendicies 1-11). Thus far, only preliminary examinations have been made on these samples.

JURASSIC STRATIGRAPHY

Figure 2 is a generalized stratigraphic chart of the Jurassic for southwestern Colorado. Throughout most of the area, the Entrada Sandstone is unconformably underlain by the Upper Triassic Dolores Formation, but at the Atkinson Creek section, near Uravan (fig. 1), the Entrada may be unconformably underlain by the Upper Triassic Kayenta Formation. This unconformity between the Triassic and Jurassic is referred to as the J-2 and is considered to be a major unconformity traceable over a wide area of the Western Interior of the United States (Pipiringos and O'Sullivan, 1978).

The Entrada Sandstone is conformably overlain by the Middle Jurassic Wanakah Formation, which in most areas consists of three members, in ascending order, Pony Express Limestone, Bilk Creek Sandstone, and marl (informal name). The Pony Express Limestone Member is present at the Big Bear Creek, Cutler Creek, Deep Creek Mesa, Fall Creek 2, Leopard Creek, and Sawpit sections (fig. 1, appendicies 2, 3, 4, 7, 8, and 10). The Pony Express Limestone pinches out westward and is absent at the Dolores River, Fall Creek 1, San Miguel Canyon, and Specie Creek sections (fig. 1, appendicies 5, 6, 9, and 11); at these sections the Entrada is conformably overlain by the the Bilk Creek Sandstone Member. The Pony Express Limestone is also absent at the westernmost section, Atkinson Creek (fig. 1, appendix 1), at this location the Entrada is conformably overlain by the undifferentiated Wanakah Formation.

The relationship of the Wanakah Formation to overlying units is unclear. At the Dolores River section (fig. 1, appendix 5) the Wanakah is overlain by the Middle Jurassic Junction Creek Sandstone; at all other sections the Wanakah is overlain by a unit referred to as the Salt Wash Member of the Morrison Formation in this paper and by Bush and others (1959, 1960), as the Tidwell Member of the Morrison Formation by R. B. O'Sullivan (oral commun., 1985), or as the Junction Creek Sandstone by Blodgett (1984). R. B. O'Sullivan (oral commun., 1985) recognizes another major Jurassic unconformity, the J-5 (Pipiringos and O'Sullivan, 1978), between the Wanakah Formation and overlying units.

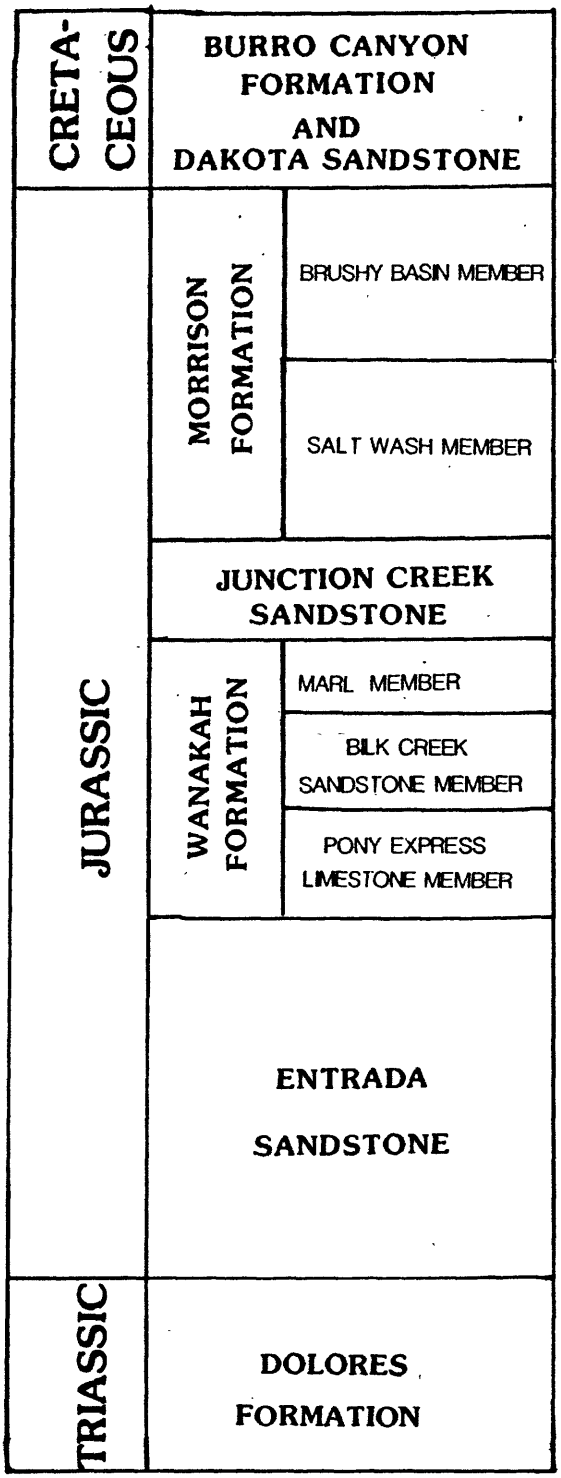

Figure 2.-- Generalized stratigraphic chart for southwestern Colorado (modified from Condon and Huffman, 1984).

ENTRADA SANDSTONE

In the sections measured, the Entrada Sandstone varies in thickness from 50 to 100 ft (15 to 30 m). The contact between Triassic and Jurassic rocks is sharp. The Dolores commonly weathers as a steep, blocky cliff and is occasionaly clay-rich at the top, whereas the Entrada weathers as an easily recognizable rounded cliff. Also, the uppermost Dolores and lowermost Entrada contain coarse-grained to granule-sized quartz and chert grains, indicating possible reworking. The Entrada is commonly bleached yellowish brown in areas where it is overlain by the Pony Express Limestone; in all other areas the Entrada is reddish brown in color. Generally, the Entrada is fine grained with abundant, scattered medium to coarse grains and is moderately sorted; it consists of very thick to thin-bedded, wedge-planar crossbedded units and thick- to very thin bedded, wavy-parallel laminated units. Thickness and distribution of these units vary between sections (appendicies 1-11). Small-scale sedimentary structures observed include inversely graded laminations and convoluted bedding. The contacts between the Entrada and the overlying Pony Express Limestone or Bilk Creek Sandstone Members is gradational.

Preliminary examinations of thin sections, heavy mineral suites, and x-ray patterns from the Entrada samples show the following petrologic features:

1. Feldspar is absent in samples from sections where the Entrada is overlain by the Pony Express Limestone.
2. In sections where the Entrada is overlain by the Bilk Creek Sandstone, except for Specie Creek (fig. 1), plagioclase and potassium feldspar are both present.
3. Dominant cements are dolomite and calcite and lesser amounts of barite and silica, but in mineralized samples no dolomite is present, only calcite.
4. Trace amounts of ooliths, lime mud intraclasts, lime peloids, and glauconite are present; especially in the upper part of the Entrada.
5. A suite of well rounded, stable heavy minerals are present, consisting of zircon, tourmaline, apatite, and altered and unaltered iron-titanium oxides; where the Entrada is overlain by the Pony Express Limestone the iron-titanium oxides are absent.

Vanadium-uranium-chromium mineralization in the Entrada Sandstone occurs regionally as two distinct, overlapping belts (one vanadium-uranium and one chromium) and closely coincides with the western pinchout of the Pony Express Limestone (fig. 3). Vanadium-uranium-chromium mineralization is present in the Fall Creek 2 and Leopard Creek sections (fig. 1, appendicies 7 and 8), and chromium mineralization is present in the Big Bear Creek, Deep Creek Mesa, Fall Creek 1, and Specie Ceek sections (fig. 1, appendicies 2, 4, 6, and 11). The mineralization is found in the upper part of the Entrada and occurs as two distinct bands separated by a barren zone (fig. 4). The vanadium-uranium band is dark green to black in color. The major vanadium minerals are roscoelite (vanadium mica) and montroseite (hydrous vanadium oxide)(Bush and others, 1959). Primary uranium minerals of unknown type are present, and secondary uranium minerals identified are coffinite and tyuyamunite (Bush and others, 1959). A green chromium band underlies the vanadium-uranium band and the major chromium mineral is considered to be mariposite (chrome mica) (Hess, 1913).

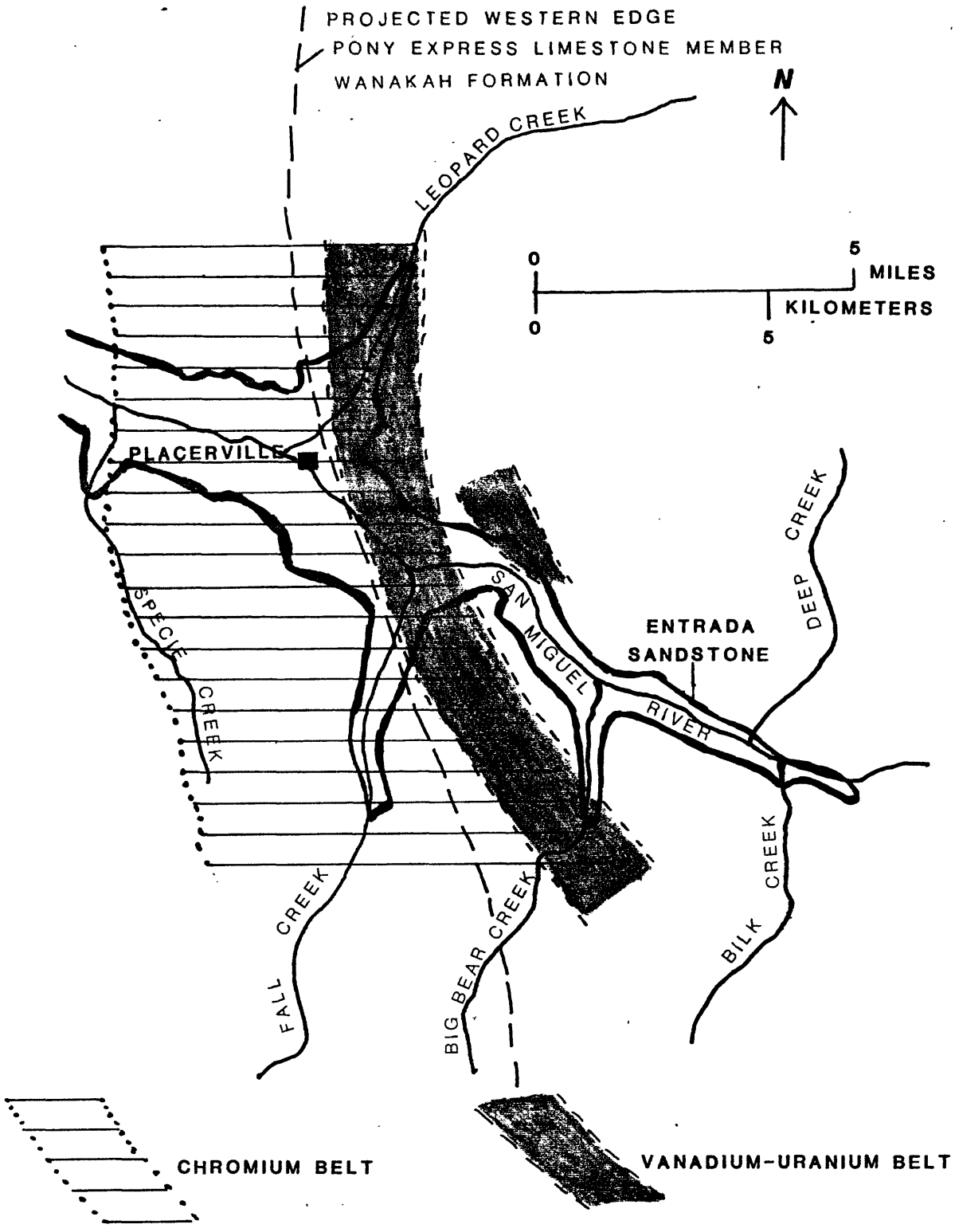

Figure 3.--Map of Placerville area, showing the approximate distribution of Entrada Sandstone outcrops and the overlapping relationship of the vanadium-uranium belts, chromium belt, and western edge of Pony Express Limestone Member of Wanakah Formation (modified from Fischer and others, 1947, and Bush and others, 1959).

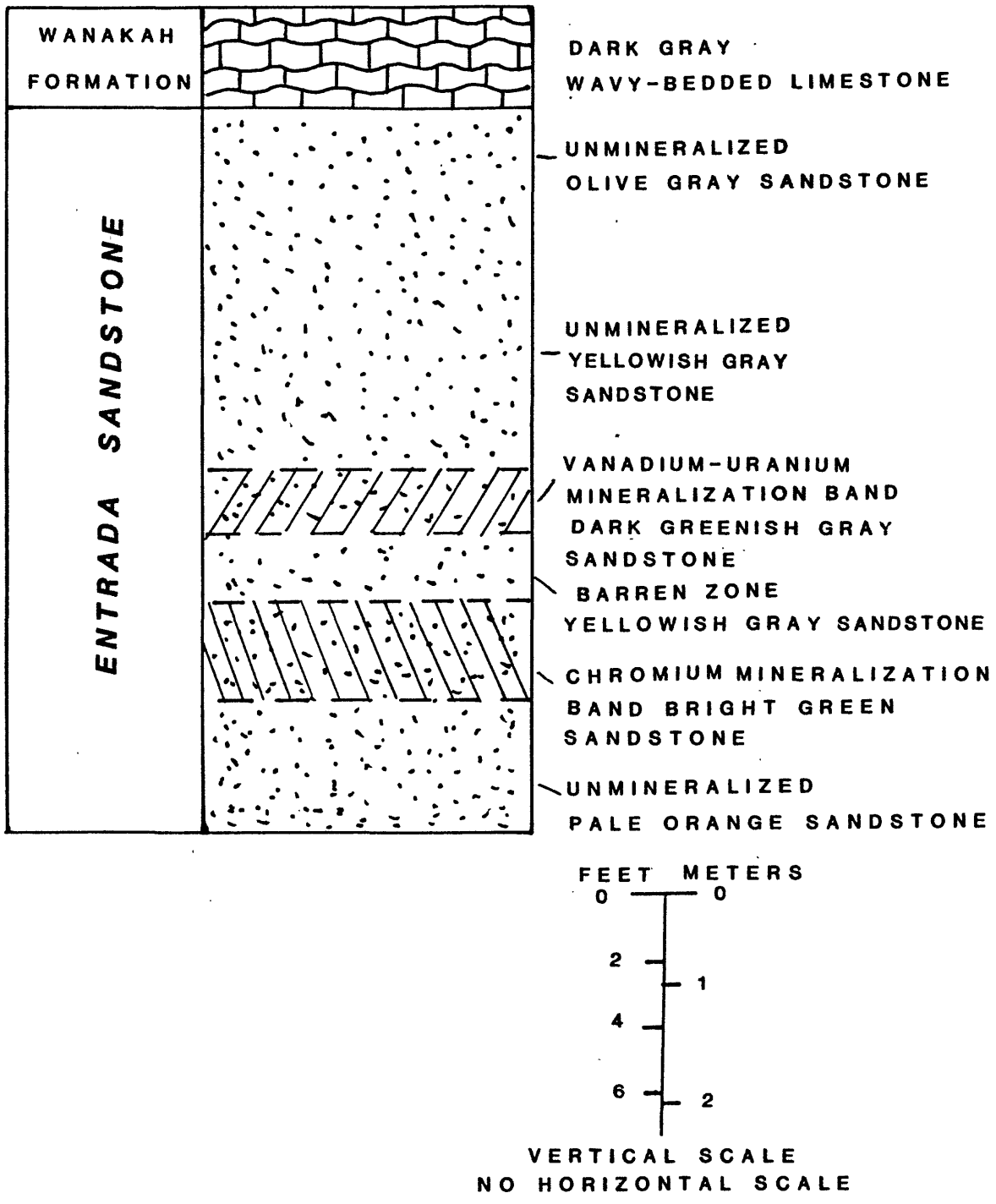

Figure 4.--Diagramatic sketch of vanadium-uranium and chromium mineralization bands in the uppermost Entrada Sandstone.

WANAKAH FORMATION

The Wanakah Formation varies in thickness from 70 to 120 ft (21 to 36 m) in the sections measured. The contact between the Wanakah and the underlying Entrada Sandstone is gradational, but the contact between the Wanakah and the overlying Junction Creek Sandstone and Salt Wash Member of the Morrison Formation is sharp. Generally, the Wanakah forms a partially covered slope between the cliff-forming Entrada Sandstone and the Junction Creek Sandstone or the Salt Wash Member.

Pony Express Limestone Member.--The Pony Express Limestone varies in thickness from 3.5 to 22 ft (1 to 6.5 m) in the sections measured, is dark gray to black in color, and forms a distinctive blocky cliff on top of the Entrada. At most sections the Pony Express Limestone is a fetid, lime mudstone with scattered silt-sized quartz and feldspar grains and traces of glauconite, unaltered and altered pyrite, and lime peloids. Ostracodes are present in the uppermost part of the Pony Express Limestone in the Deep Creek Mesa and Big Bear Creek sections (fig. 1), and a small fossil fish (?) fragment was observed at the Fall Creek 2 section (fig. 1). The Pony Express Limestone commonly forms 1.2 to 12 in (3 to 10 cm) thick wavy beds with scattered lenses of silt- to sand-sized material. Within each bed the limestone is laminated with thin shale and sandy siltstone layers (fig. 5). At the Cutler Creek section (fig. 1) the Pony Express is made-up of two distinct units, a lower unit consisting of interbedded thin dark gray sandstone, limestone, and shale beds; and an upper unit consisting of a lighter gray calcite-cemented, vuggy, massive, limestone-clast breccia (appendix 3). The contact between the Pony Express Limestone and the overlying Bilk Creek Sandstone usually forms a noticeable break in slope.

Bilk Creek Sandstone Member.--Thickness of the Bilk Creek Sandstone in the sections measured varies from 6 to 35 ft (2 to 10.5 m). Where the Bilk Creek Sandstone is underlain by the Pony Express Limestone, the Bilk Creek Sandstone is bleached light gray in color; in all other sections it is dominantly reddish brown in color. The Bilk Creek Sandstone consisits of two recognizable units. The lower unit is clay-rich, calcite- and dolomite-cemented, quartz sandstone that is fine-grained, moderately sorted, and feldspathic. At the Sawpit and Dolores River sections (fig. 1) this unit contains ostracodes, ooliths, and lime mud intraclasts. This lower unit, where bleached, appears structureless with occasional discontinuous clay stringers, but in sections where the Bilk Creek Sandstone is not bleached the lower unit is bioturbated. The lower unit forms a rounded cliff that becomes more clay-rich and less resistant upward, and is overlain by a 1 to 3 ft (.5 to 1 m), light colored, well cemented, structureless unit referred to by Cross and Purington (1899) and by Goldman and Spencer (1941) as the carnelian sandstone bed. The carnelian sandstone is generally medium grained, moderately to poorly sorted, and feldspathic; it contains scattered red chert (carnelian) grains, lime mud intraclasts, and ooliths. The well-indurated carnelian sandstone bed forms a small ledge at the top of the Bilk Creek Sandstone. The contact between the Bilk Creek Sandstone Member and marl member is distinct, forming a break in slope.

Marl member.--The marl member varies in thickness from 45 to 85 ft (13.5 to 26 m), is dominantly reddish brown in color, and is nonresistant, forming a

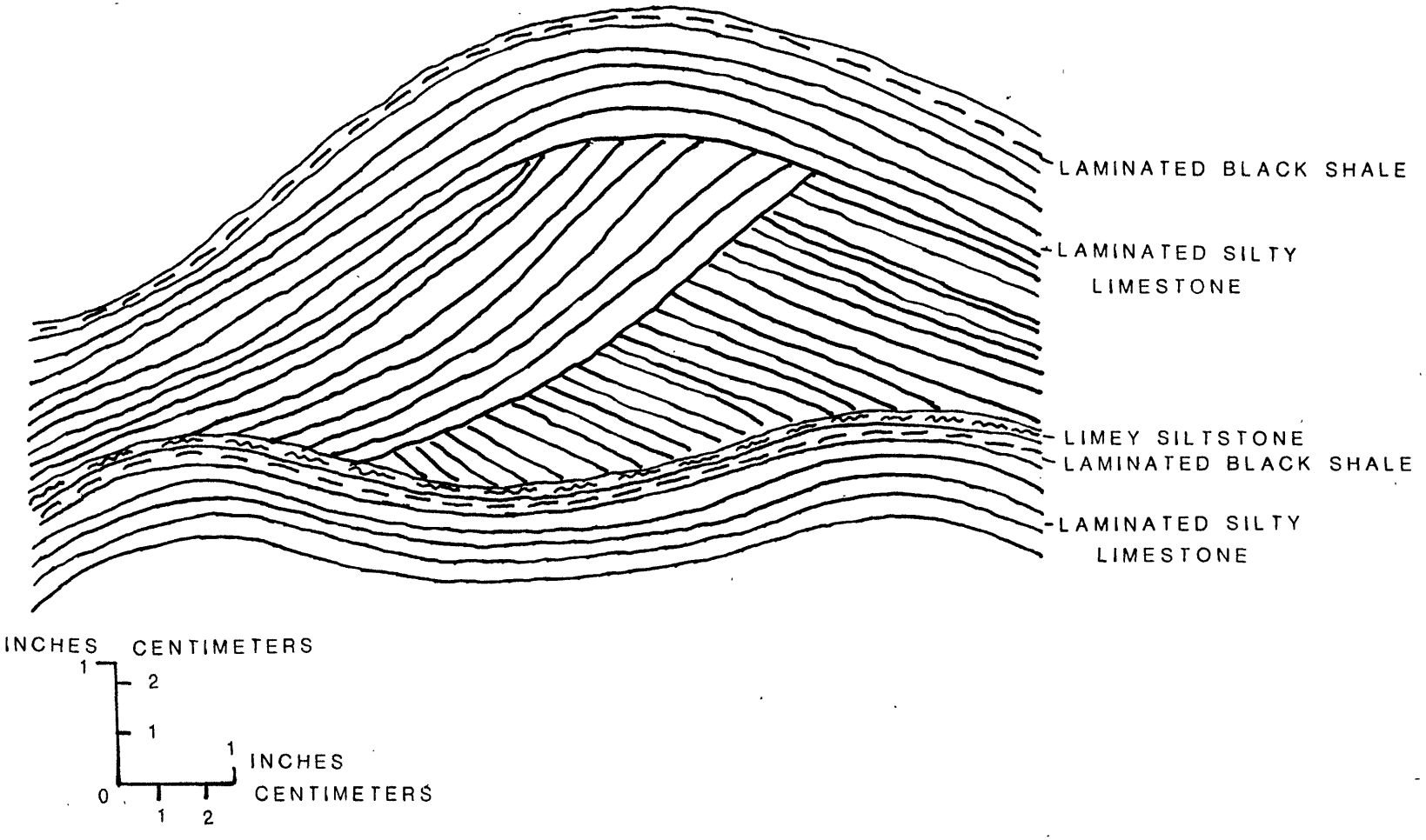

Figure 5.--Diagramatic sketch of unusual small-scale sedimentary structures in Pony Express Limestone Member of Wanakah Formation.

partially covered slope. At most sections the marl consists of alternating thin lenticular beds of sandstone, siltstone, mudstone, and claystone. These units appear to be structureless, except for a few scattered discontinuous, wavy-parallel laminations and trough crossbedding in one of the sandstone units in the upper part of the marl at the Dolores River section (fig. 1, appendix 5). Sandstones of the marl are generally fine-grained, moderately sorted, feldspathic, clay-rich, dolomite- and calcite- cemented, and feldspathic with traces of lime peloids, lime mud intraclasts, chert and chalcedony fragments, glauconite, and ostracodes. Secondary red chalcedony concretions are common in the claystone and mudstone units. At Big Bear Creek, Deep Creek Mesa, Fall Creek 1 and 2, Leopard Creek, and Sawpit sections (fig. 1, appendicies 2, 4, 6, 7, 8, and 10) there is a distinctive, very thin dolomitic limestone unit that contains secondary red and green chalcedony concretions. This unit is found about 15 ft (4.5 m) above the carnelian sandstone bed in all of these sections and may be correlatable. Also, associated with this unit is a bright green clay mineral identified as an unusual iron-rich type of illite (G. N. Breit, oral commun., 1985). The contact between the marl member and the overlying, more resistant Salt Wash Member of the Morrison Formation or the Junction Creek Sandstone is sharp, and the uppermost marl is bleached greenish gray in many places.

Wanakah Formation undifferentiated.--At the westernmost section, Atkinson Creek (fig. 1), the three members of the Wanakah Formation are not distinqiushable, and in this report the interval between the Entrada and Salt Wash is referred to as the Wanakah Formation undifferentiated. Williams (1964) refers to the same interval as the Summerville Formation. The Wanakah Formation is 70 ft (21 m) thick at this location. The lower 30 ft (9 m) is dominantly structureless, pinkish-gray to orange-pink, resistant sandstone that contains a few thin clay breaks. This lower portion is similar to the Bilk Creek Sandstone Member, but there is no recognizable carnelian sandstone bed. The upper part of the Wanakah is less resistant and consists of alternating, thin, lenticular beds of structureless, light-brown sandstone, siltstone, mudstone, and claystone. Sandstones of the Wanakah in this area are generally fine-grained, moderately sorted, clay-rich, dolomite- and silica-cemented, and feldspathic. The contact between the Wanakah and the overlying Salt Wash Member is sharp.

JUNCTION CREEK SANDSTONE

The Junction Creek Sandstone is only present at the Dolores River section (fig. 1, appendix 5). At this location the Junction Creek is 270 ft (82 m) thick, is pale red to yellowish-gray in color, and forms a resistant cliff. The majority of the Junction Creek Sandstone consists of very thick to thin bedded, tabular-planar crossbedded units; one individual crossbed set is 70 ft (21 m) thick. Small-scale sedimentary structures include inverse-graded laminations, pull-apart structures, and small-scale slumps. The lower one-third of the Junction Creek contains several thin, clay-rich sandstone units that have discontinuous wavy-parallel laminations. At the Dolores River section the Junction Creek is fine- to medium-grained, moderately sorted, feldspathic, calcite- and silica-cemented quartz sandstone that has traces of detrital chert and chalcedony fragments and silicified fossiliferous (algal?) limestone fragments, similar to those found in the lower Salt Wash Member, near Placerville. The contact between the Junction Creek and the overlying Salt Wash Member is covered in this area.

SALT WASH MEMBER OF MORRISON FORMATION

The Salt Wash Member of the Morrison Formation ranges in thickness from 300 to 365 ft (91 to 110 m) in the Placerville area (Bush and others, 1959), but only the lower 40 to 50 ft (12 to 15 m) were examined in this study. In most areas, the Salt Wash interval examined consists of resistant, yellowish gray, thin- to medium- bedded, wavy-parallel and nonparallel laminated (ripple laminated) sandstone with discontinuous, very thin clay breaks. Mudcracks, horizontal burrows, and load structures are associated with these clay breaks in some places. The sandstones are fine- to medium-grained, moderately sorted, dolomite- and silica-cemented, and feldspathic and contain detrital chert, chalcedony, lime mudstone, and claystone fragments. In addition, silicified fossiliferous (algal?) limestone fragments are common, especially in the basal part of the Salt Wash. Thin limestone units are also present in this lower Salt Wash interval in the Atkinson Creek, Cutler Creek, Deep Creek Mesa, and San Miguel Canyon sections (fig. 1, appendicies 1, 3, 4, and 9). These limestones are largely recrystallized, structureless lime mudstone and contain scattered silt-sized quartz and feldspar grains. The limestone from the Atkinson Creek and Cutler Creek sections also contains ostracodes and lime peloids, and the limestone from San Miguel Canyon contains gypsum (?) casts. This lower Salt Wash interval is scoured into by trough crossbedded Salt Wash channel sandstones at most sections, except Fall Creek 2 and Sawpit sections (fig. 1, appendix 7 and 10). In these two sections the lower Salt Wash is absent and the trough crossbedded Salt Wash cuts into the uppermost Wanakah Formation.

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APPENDICIES 1-11

EXPLANATION OF COLUMNS ON STANDARDIZED STRATIGRAPHIC DESCRIPTION FORM

Column 1 - Thickness/Sample No.
All measurements in feet, marked at 10 foot intervals
▲ Sample taken at that footage
HM Heavy mineral sample taken at that footage

Column 2 - Unit No.
Column not used

Column 3 - Formation/Member

Ṟd	Triassic Dolores Formation
Ṟk	Triassic Kayenta Sandstone
Je	Jurassic Entrada Sandstone
Jwpe	Jurassic Wanakah Formation/Pony Express Limestone Member
Jwbc	Jurassic Wanakah Formation/Bilk Creek Sandstone Member
Jwmm	Jurassic Wanakah Formation/marl member (informal name)
Jw	Jurassic Wanakah Formation undifferentiated
Jjc	Jurassic Junction Creek Sandstone
Jms	Juraasic Morrison Formation/Salt Wash Member

Column 4 - Radioactivity (cps)
Counts per second (cps) measured with hand-held scintillometer
Bkgd-background

Column 5 - Visual Porosity Estimate
Based on amount of interstitial clay, degree of cementation, and by placing a drop of HCL on the sample.

Column 6 - Core
If column darkened means zone of uranium-vanadium or chromium mineralization

Column 7 - Rock Type
Lithologic column drawn with weathering profile. (see pages 18-19 for lithologic symbols)

Column 8 & 9 - Footnotes/Color (combined)
All rock colors compared with standard rock color chart (Goddard and others, 1948).

Column 10 - Dominant Grain Size

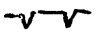
Solid line is dominant grain size of unit; dots indicate less abundant grain sizes.

Column 11 - Bedding (modified from Reynolds and others, 1975)

Bed Thickness	Scale
vthk-very thick bedded	>40 in (>100 cm)
thk-thick bedded	12-40 in (30-100 cm)
med-medium bedded	4-12 in (10-30 cm)
thn-thin bedded	1.2-4 in (3-10 cm)
lam-laminated	<1.2 in (<3 cm)
mass-massive bedded	homogeneous

Column 12 - Sedimentary Structures

dwll discontinuous wavy parallel laminations
dwNl discontinuous wavy nonparallel laminations
wll wavy parallel laminations
wNl wavy nonparallel laminations
cll curved parallel laminations
ell even parallel laminations
m<ell moderate angle even parallel laminations
l<ell low angle even parallel laminations
N no apparent sedimentary structures

 mudcracks

 load casts

 contorted bedding

Column 13 - Biology/Organics

 algal

 horizontal burrow

 bioturbated

 organic material

Column 14 - Sorting/Roundness

Sorting and roundness are visual estimates.

W	well sorted	SR	subrounded
M	moderately sorted	SA	subangular
P	poorly sorted	A	angular
		R	rounded

Column 15 - Cement

SlC	slightly calcareous
MC	moderately calcareous
VC	very calcareous
NC	noncalcareous
SiO_2	silica cement

Column 16 - Percent Feldspar

Visual estimate

Column 17 - Accessory Mineral Fragments

red cht	red chert
blk op	black opaque
cht	chert

Column 18 - Notes

Comments and miscellaneous information

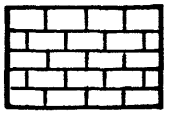
Column 19 - Inferred Environment of Deposition

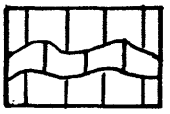
Preliminary interpretation inferred from primary sedimentary structures and facies relationships.

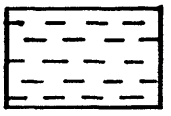
Column 20 - Transport Direction

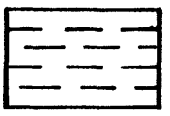
Crossbed direction readings

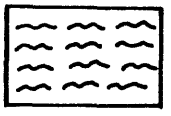
LITHOLOGIC SYMBOLS

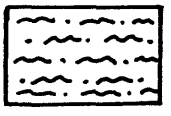

Limestone

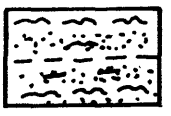

Limestone/wavy bedded

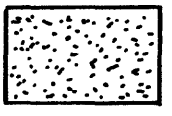

Claystone

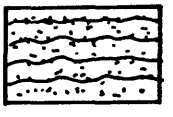

Shale

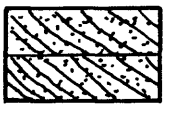

Siltstone

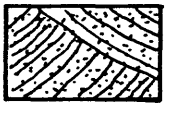

Mudstone


Interbedded sandstone, siltstone, mudstone, and claystone


Sandstone/structureless

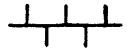

Sandstone/wavy parallel laminations


Sandstone/tabular-planar crossbed sets


Sandstone/wedge-planar crossbed sets


Clasts (limestone, chert, or clay)


Voids



Calcareous

Bioturbated

Contorted bedding

Covered interval

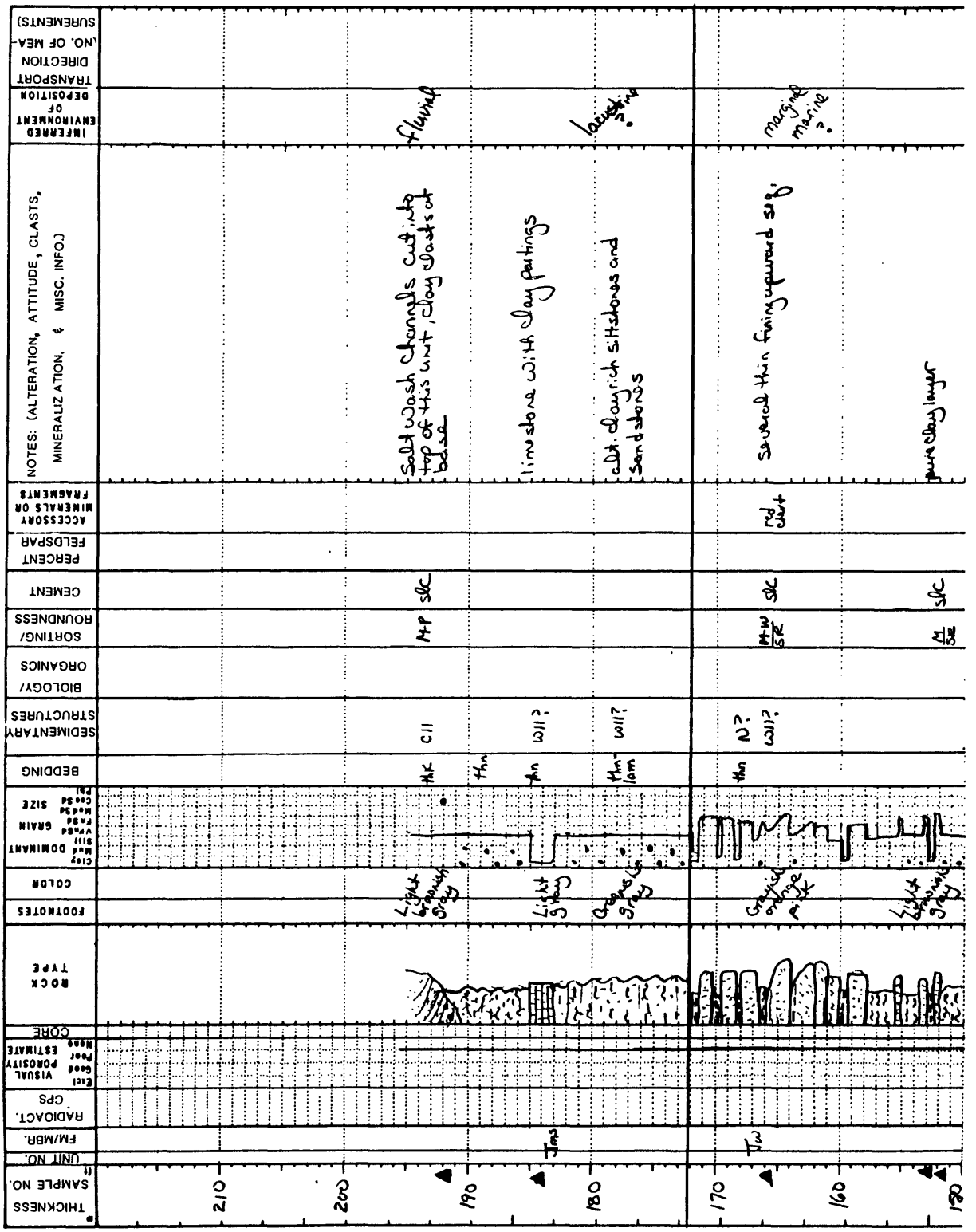
Mudcracks

Load structures

LOCATION Atkinson Creek Sec 28 T. 48N R17W QUADRANGLE (7.5') Red Canyon

STATE Colorado COUNTY Montrose DATE 9/84

LAT.-LONG. GEOL.

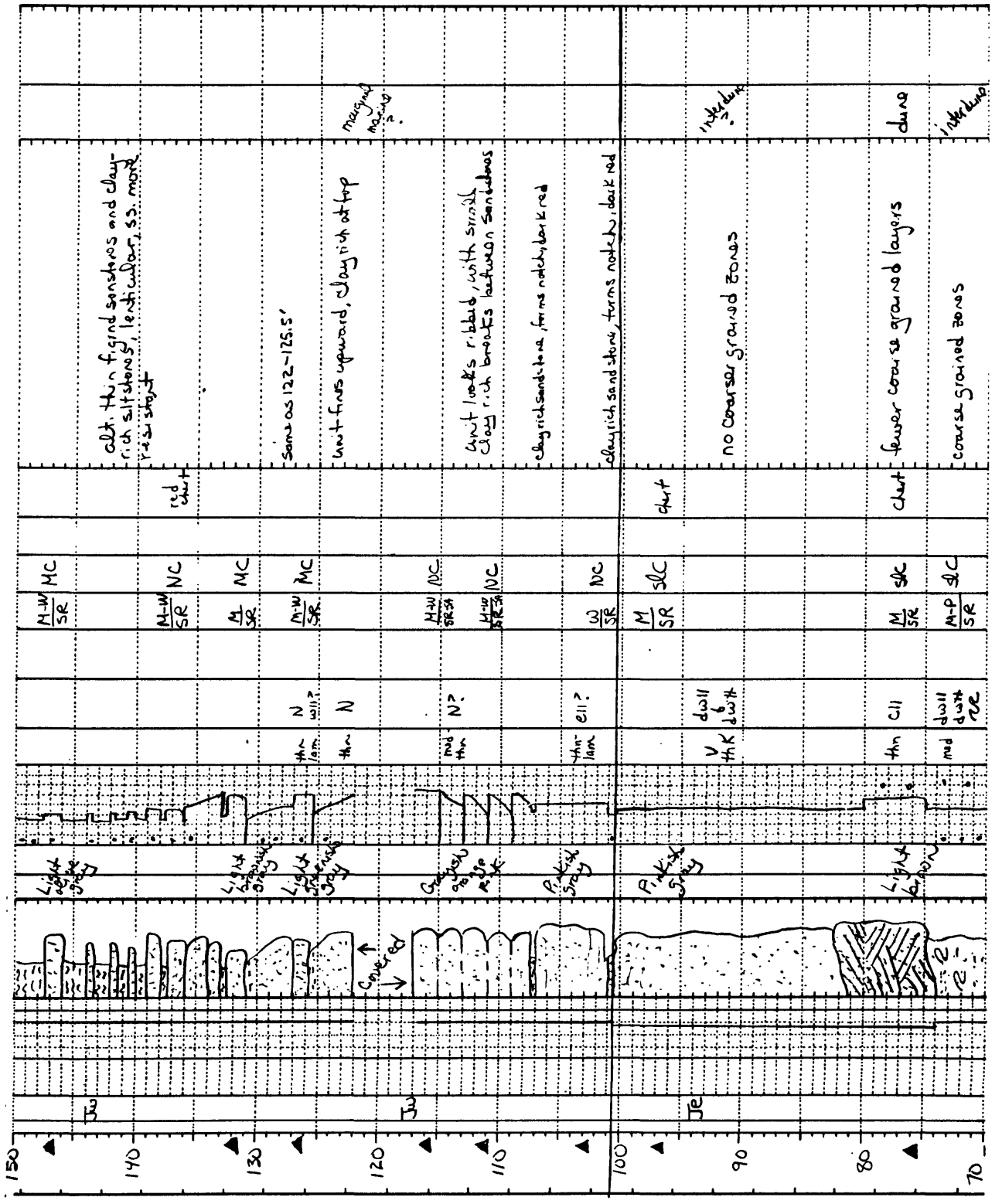


Appendix 1.-- Atkinson Creek section.

LOCATION Atkinson Creek Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

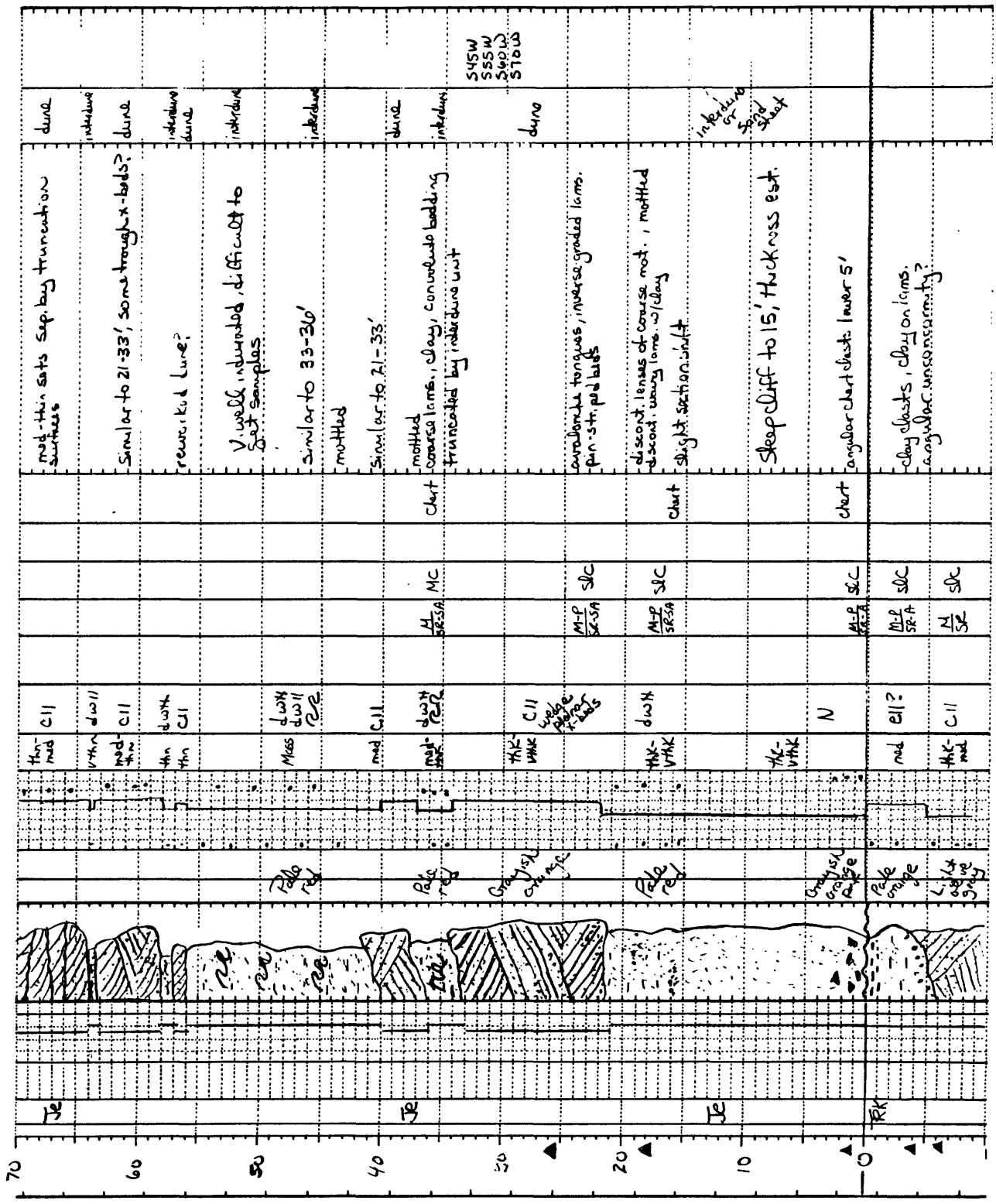


Appendix 1.-- (cont.)

LOCATION Atkinson Creek Sec. T. R.

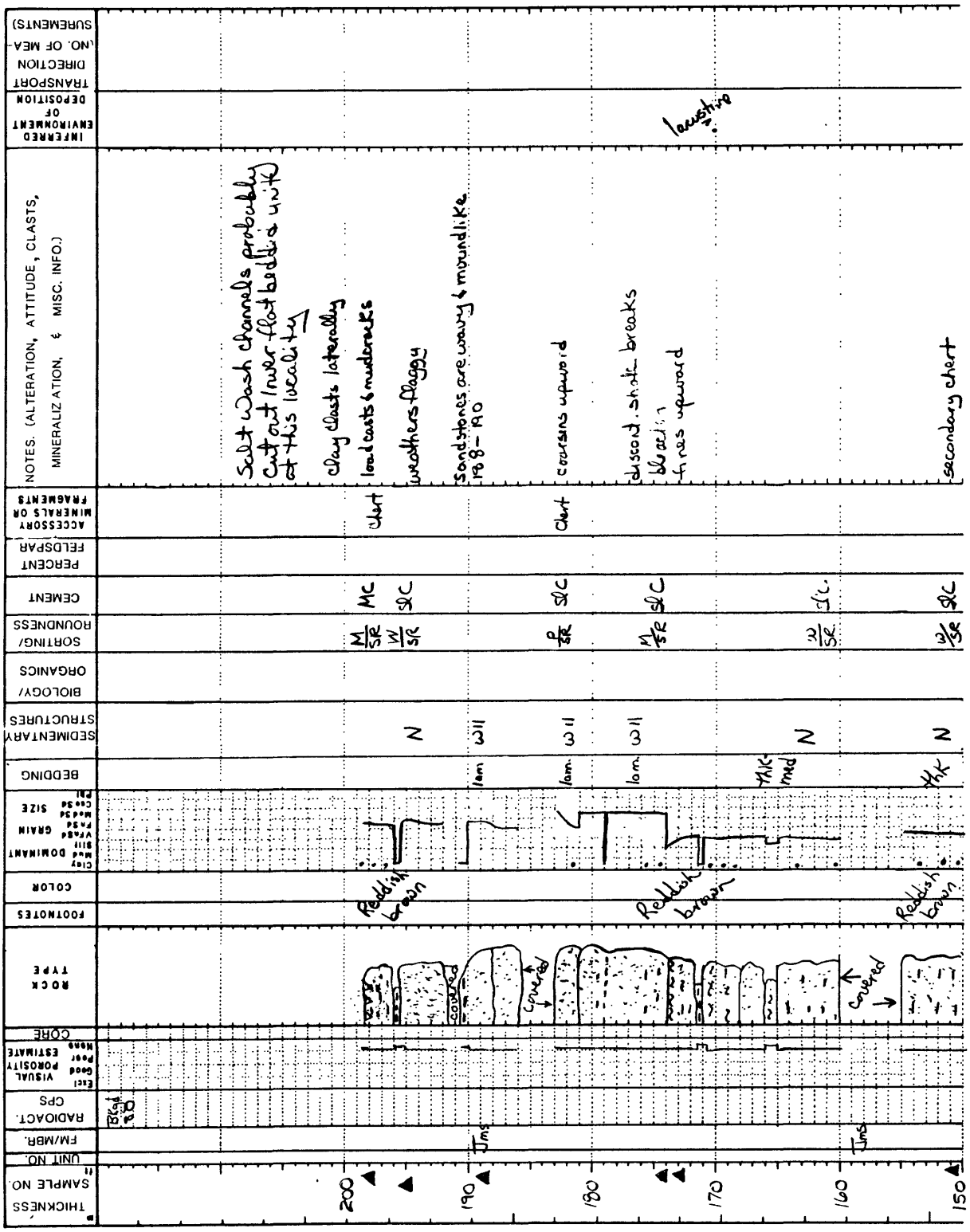
STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER



Appendix 1.-- (cont.)

LOCATION Big Bear Creek Sec 33 T 43N R 10W QUADRANGLE (7.5') Grey Head
STATE Colorado COUNTY San Miguel DATE 7/83 6/9/84
LAT.-LONG. GEOL.

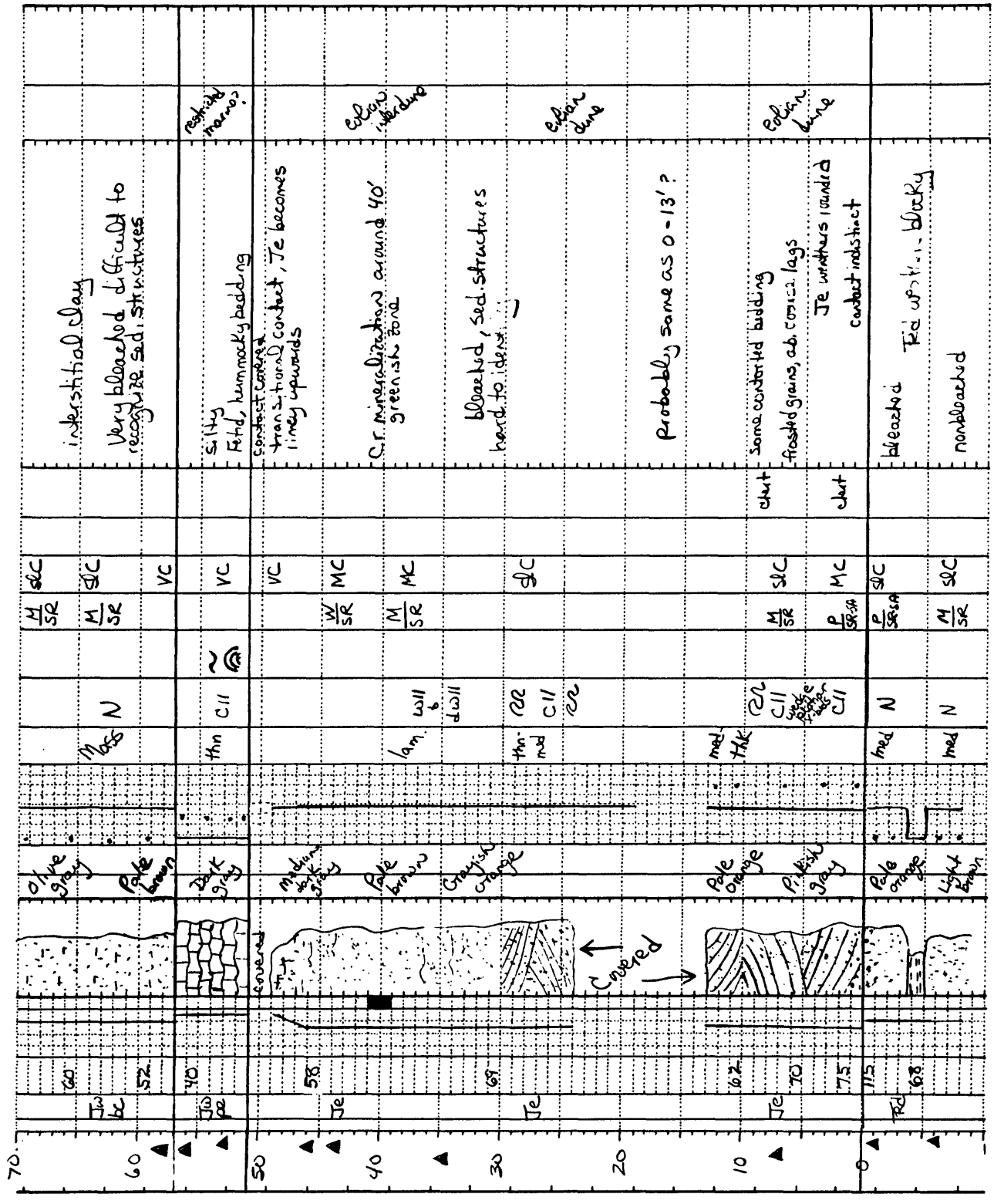


Appendix 2.-- Big Bear Creek.

LOCATION Big Bear Creek Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

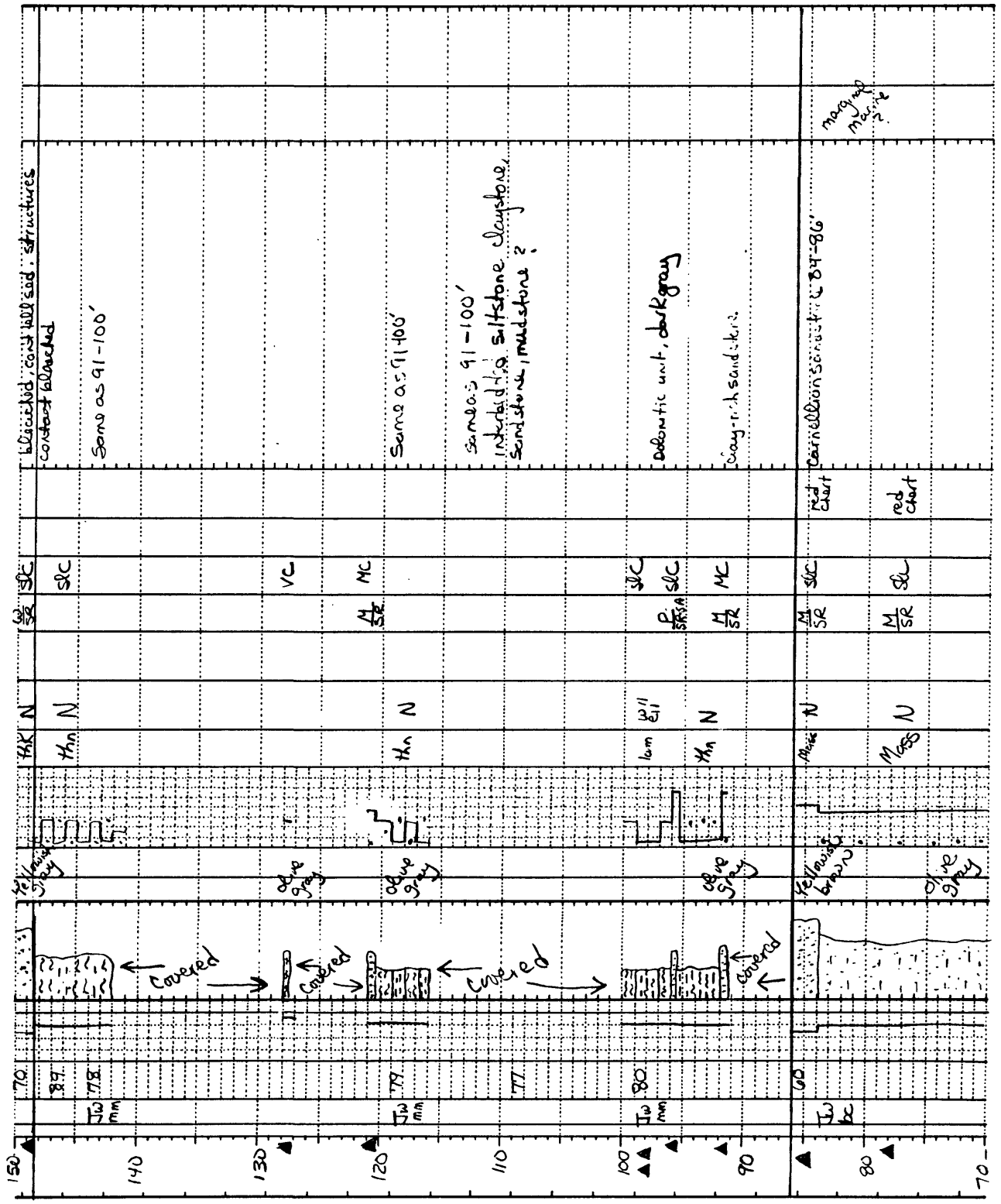


Appendix-- 2. (cont.)

LOCATION Big Bear Creek Sec. T. R.

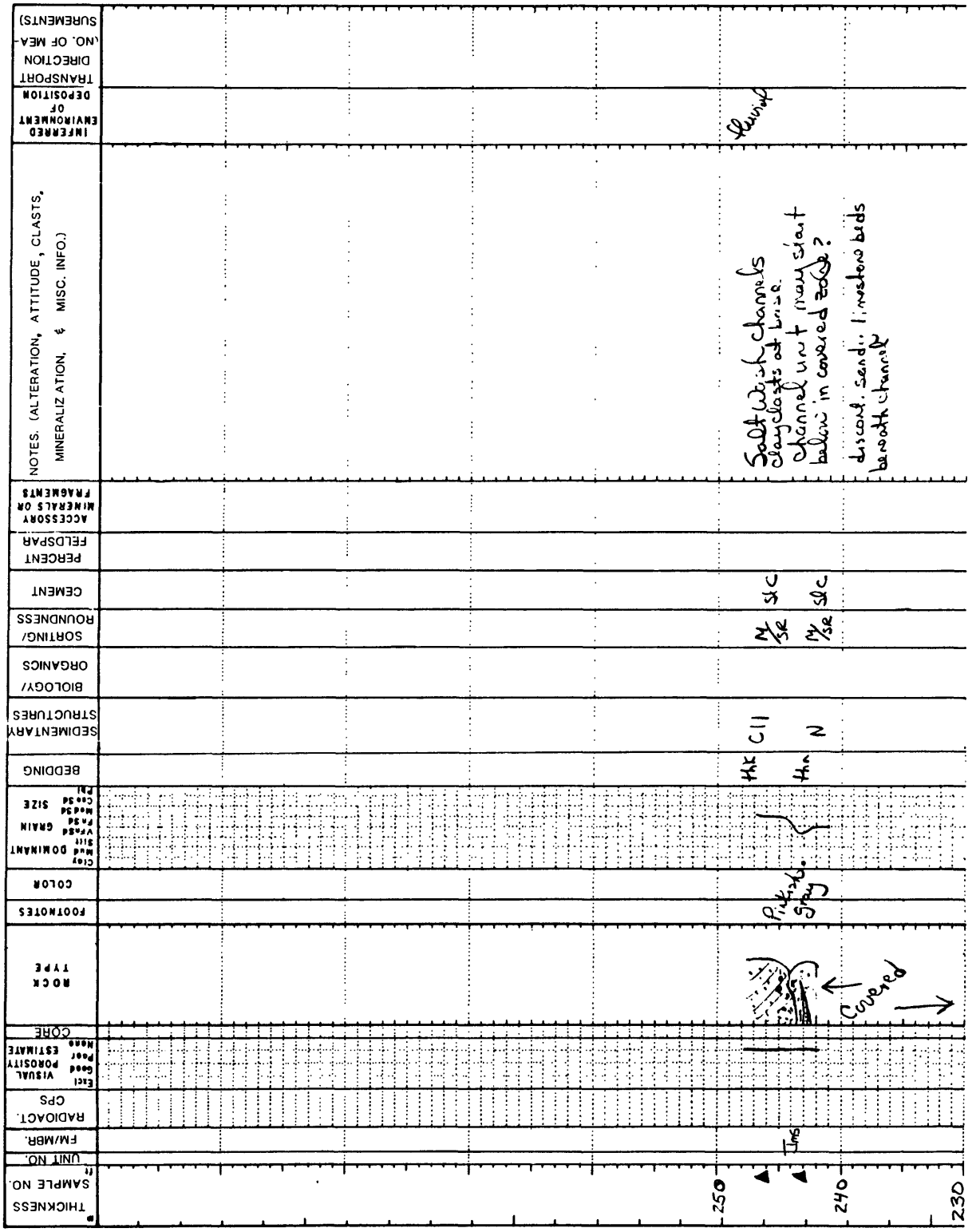
STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

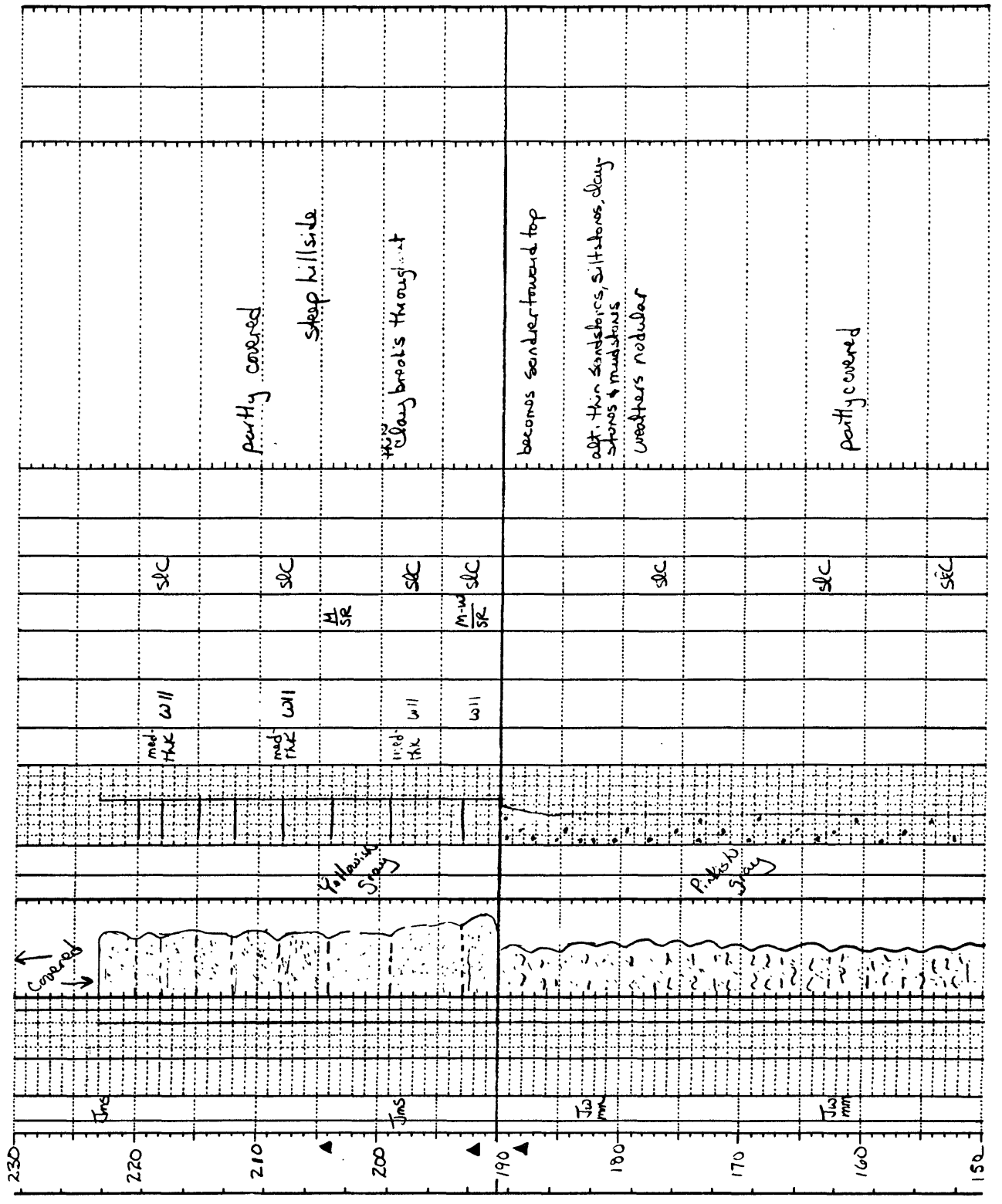


Appendix-- 2. (cont.)

LOCATION Cutler Creek Sec. 1 T.44N R.8W QUADRANGLE (7.5') Ouray
STATE Colorado COUNTY Ouray DATE 9/84
LAT.-LONG. GEOL.



Appendix 3.-- Cutler Creek section.

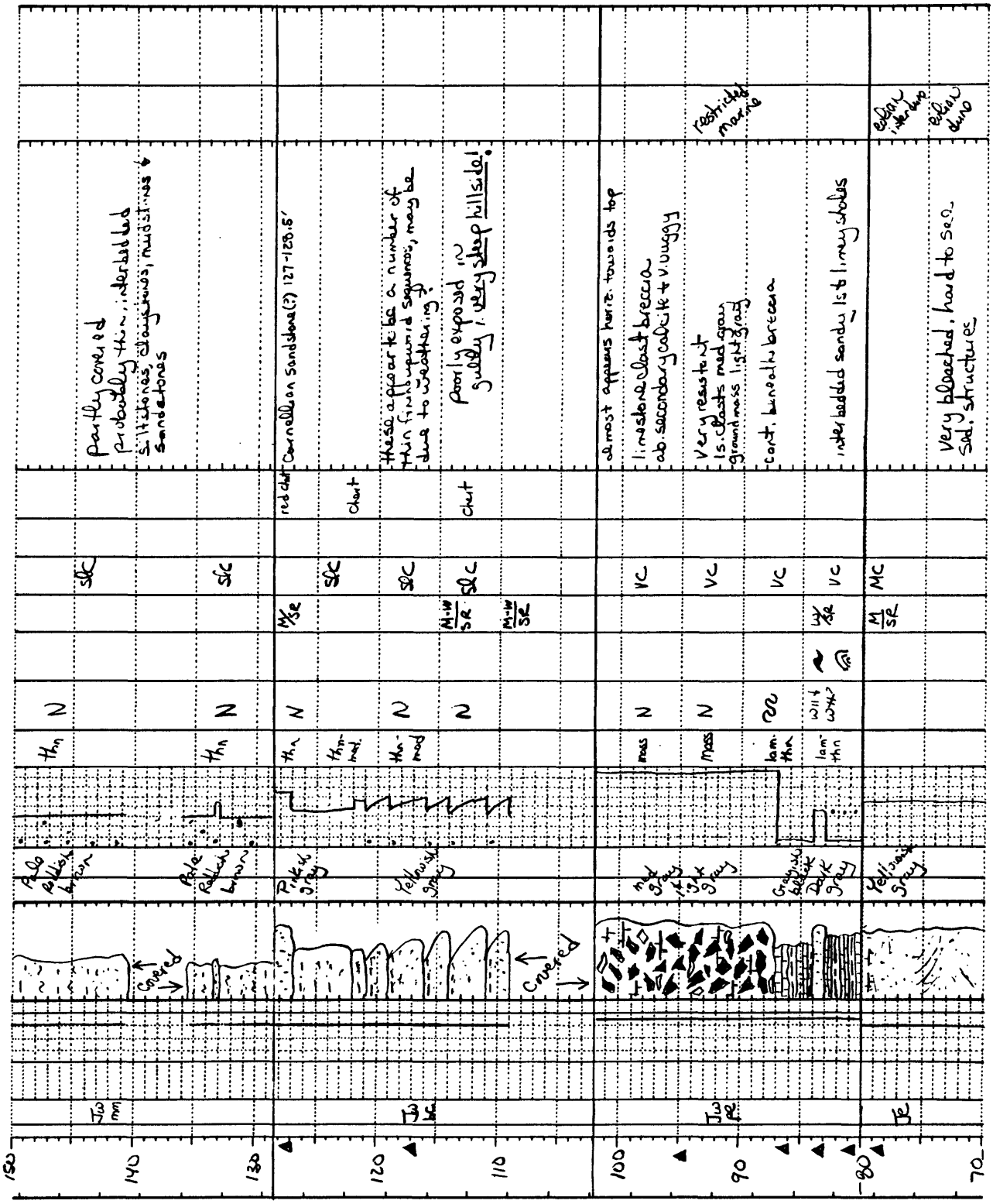


Appendix 3.-- (cont.)

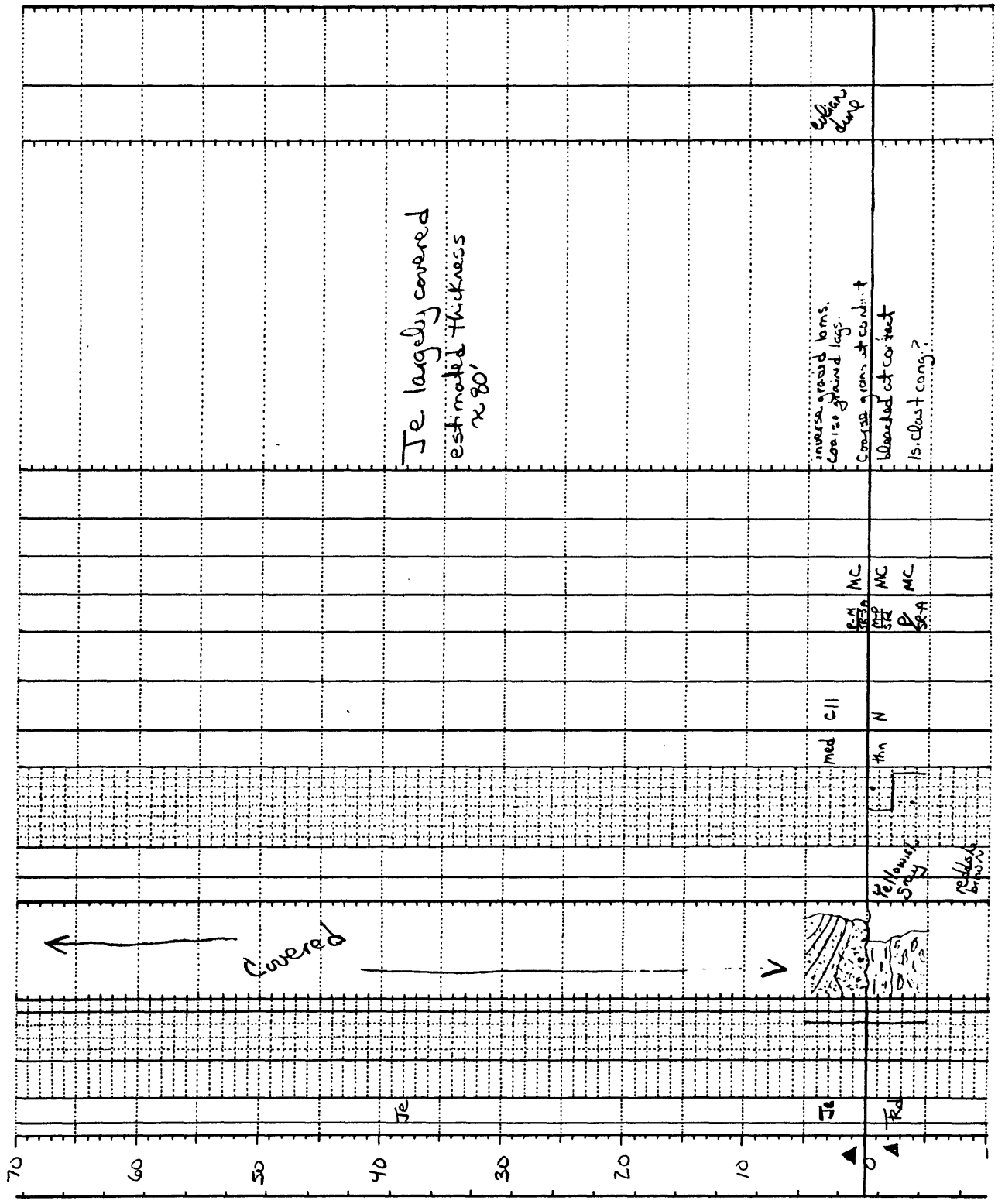
LOCATION Cutler Creek Sec. T. R.

STATE COUNTY

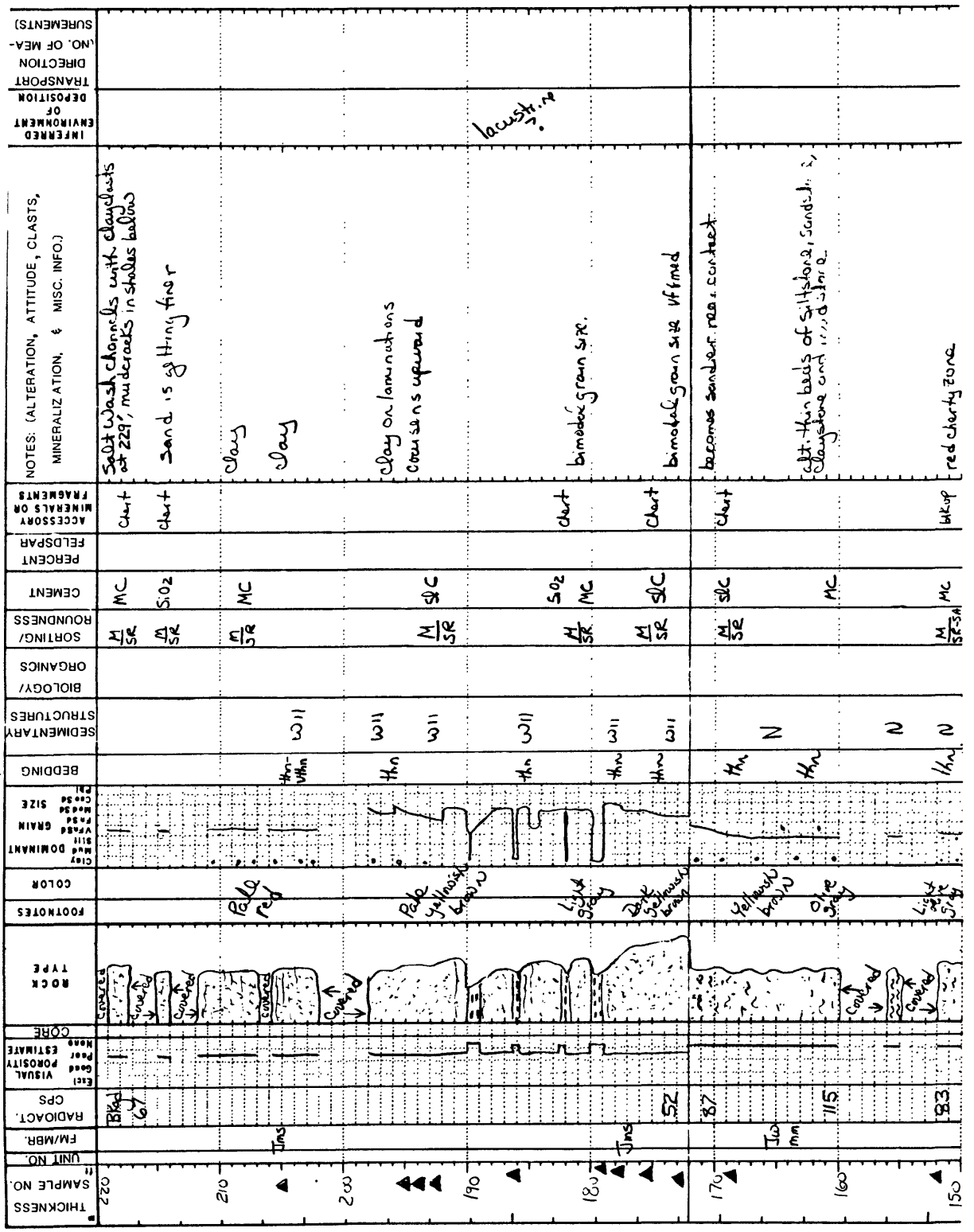
U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER



Appendix 3.-- (cont.)



Appendix 3.-- (cont.)

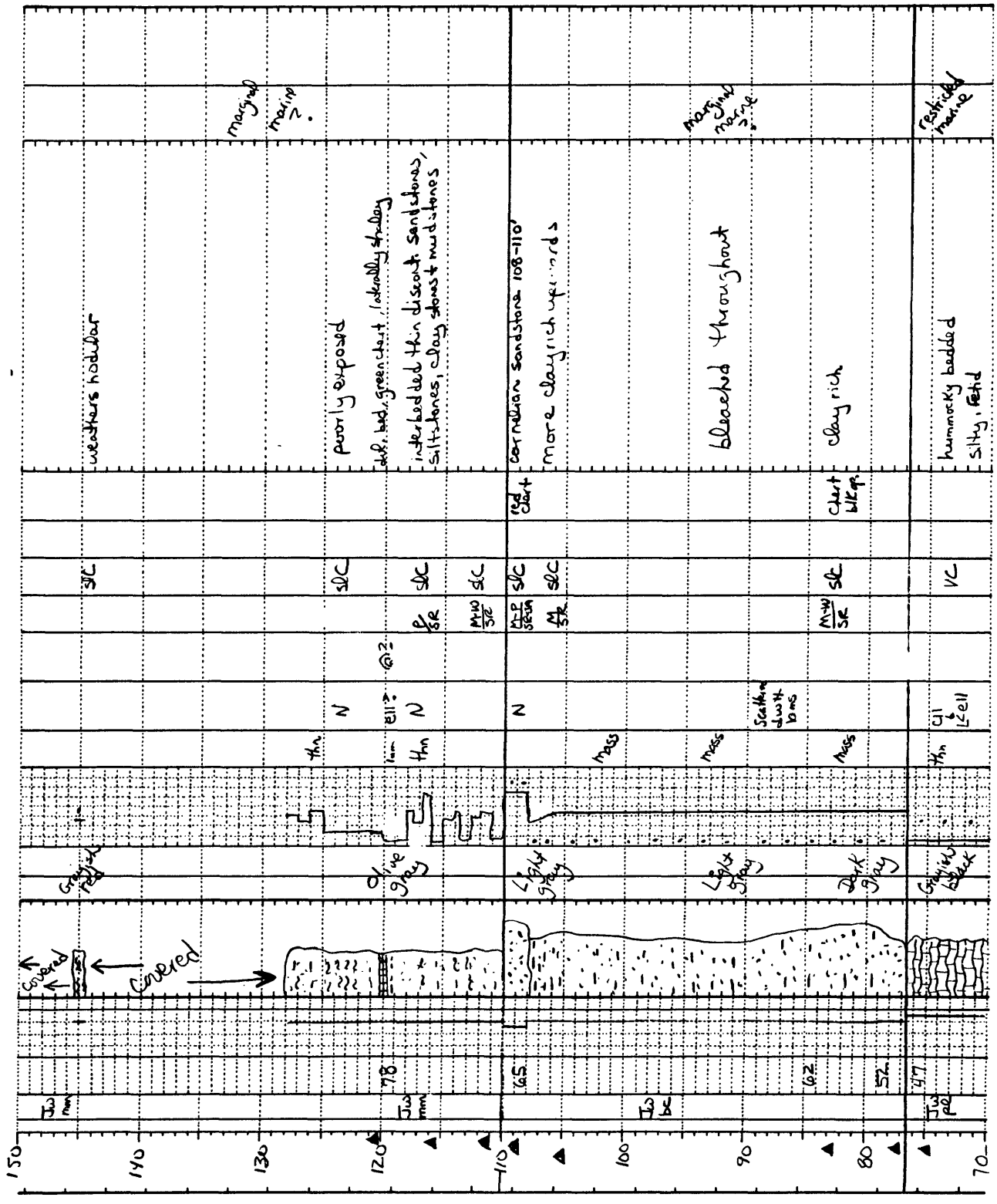


Appendix 4.-- Deep Creek Mesa section.

LOCATION Deep Creek Mesa Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

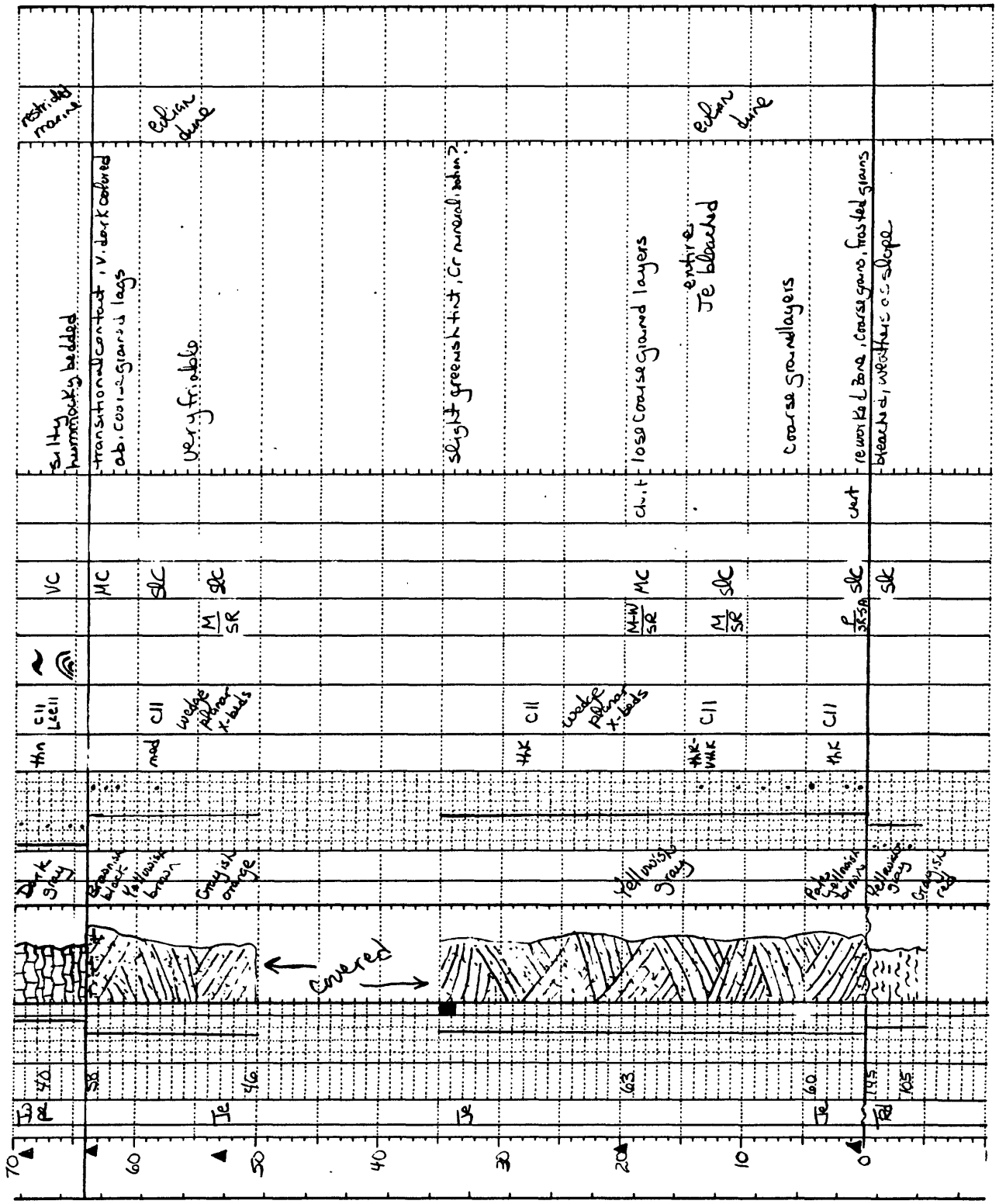


Appendix 4.-- (cont.)

LOCATION Deep Creek Mesa Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

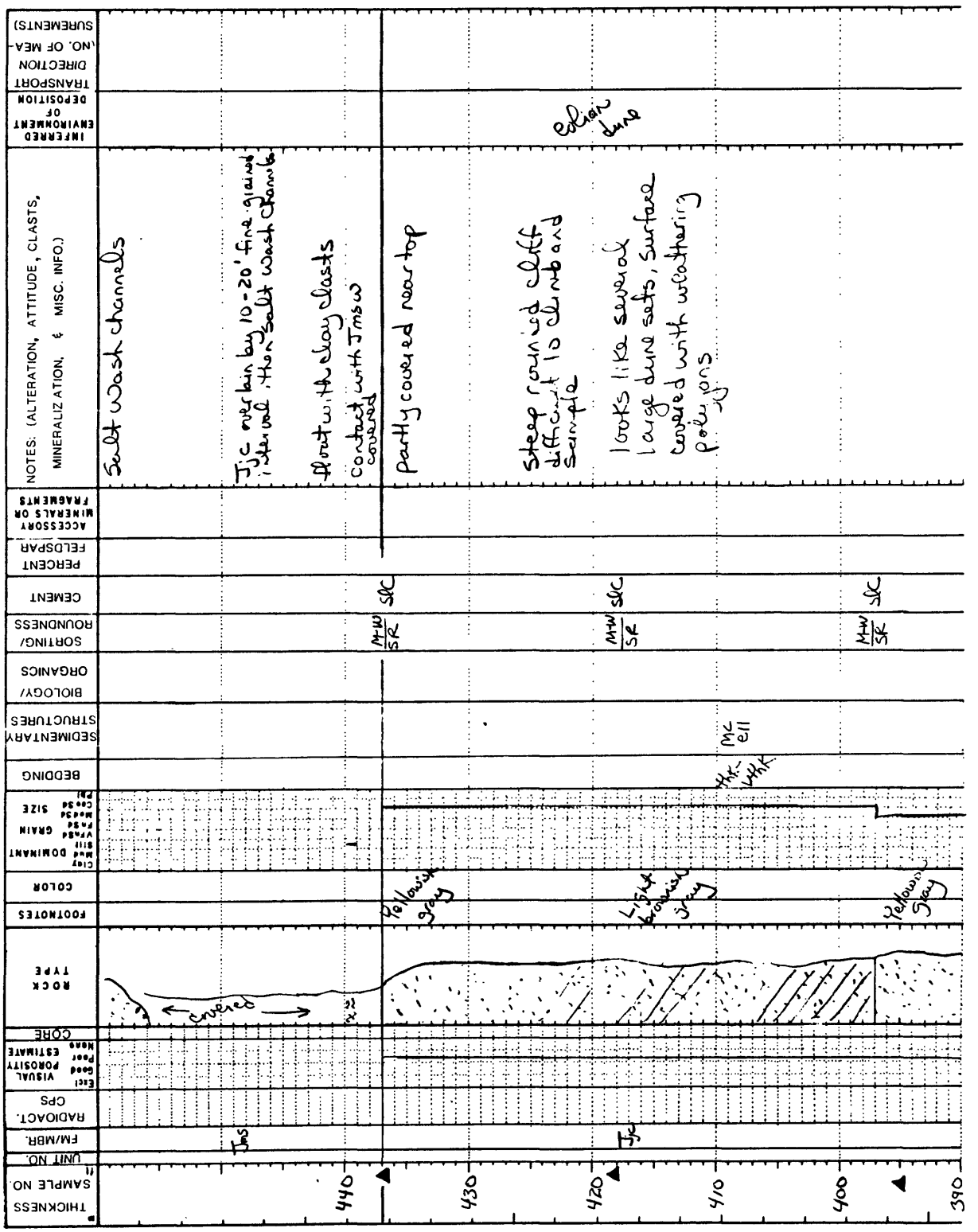


Appendix 4.-- (cont.)

LOCATION Dolores River Sec. 11 T. 38N R. 14W QUADRANGLE (7.5') Stoner

STATE Colorado COUNTY Montezuma DATE 4/84

LAT.-LONG. GEOL.

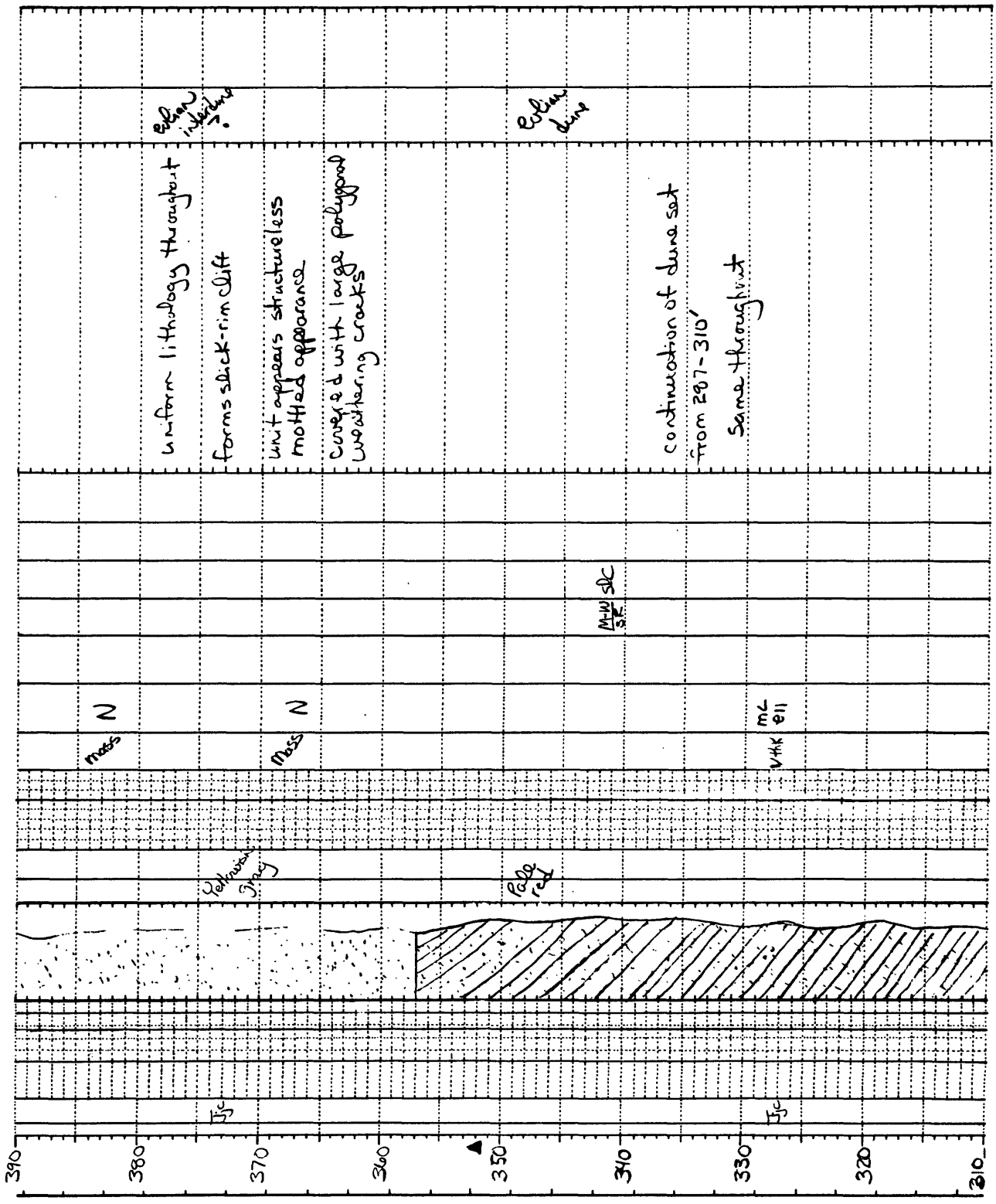


Appendix 5.-- Dolores River section.

LOCATION Dolores River Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

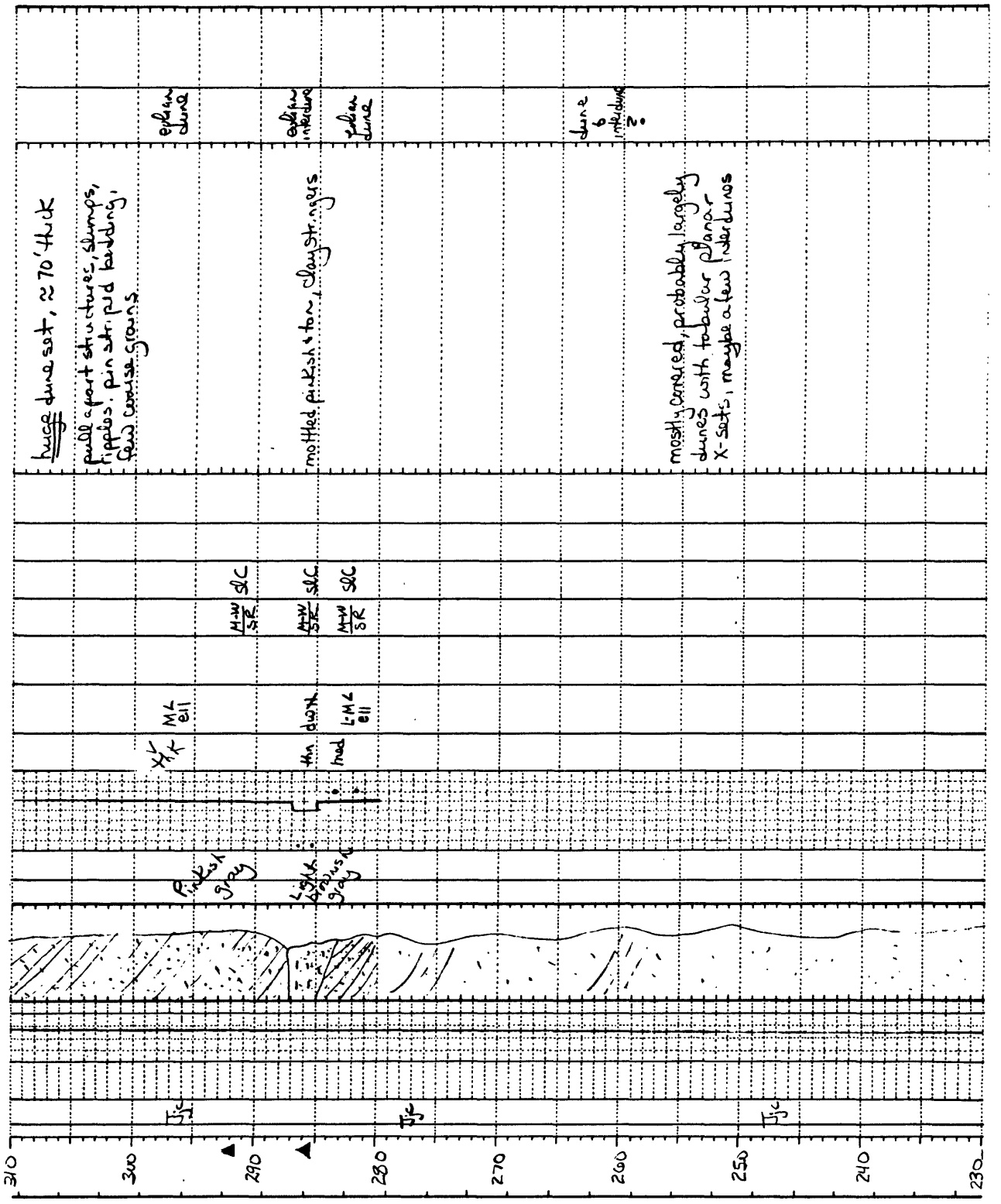


Appendix 5.-- (cont.)

LOCATION Dolores River Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

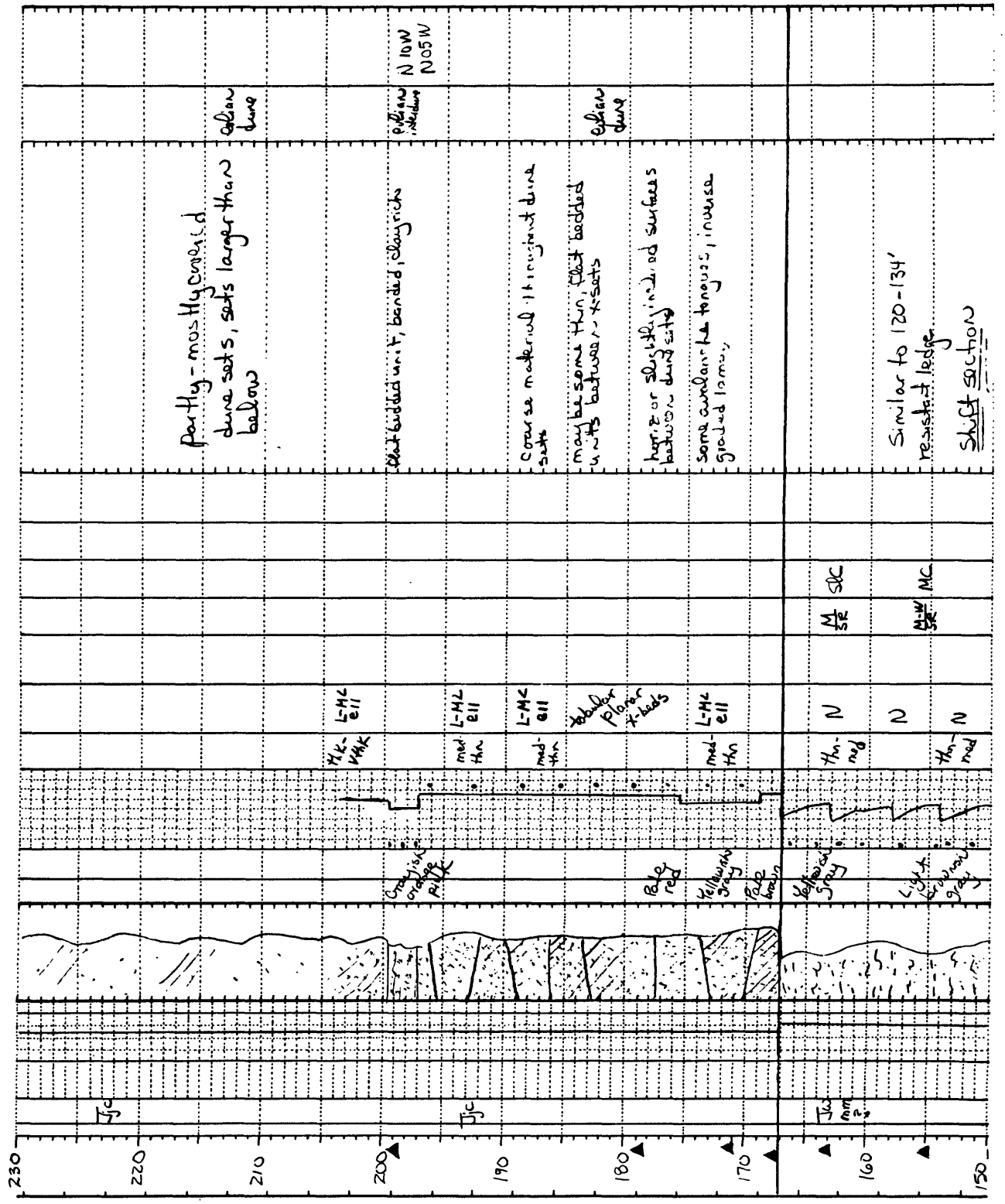


Appendix 5.-- (cont.)

LOCATION Dolores River Sec. 11 T. 38N R. 14W

STATE Colorado COUNTY Montezuma (Stoner 7.5' Quad.)

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

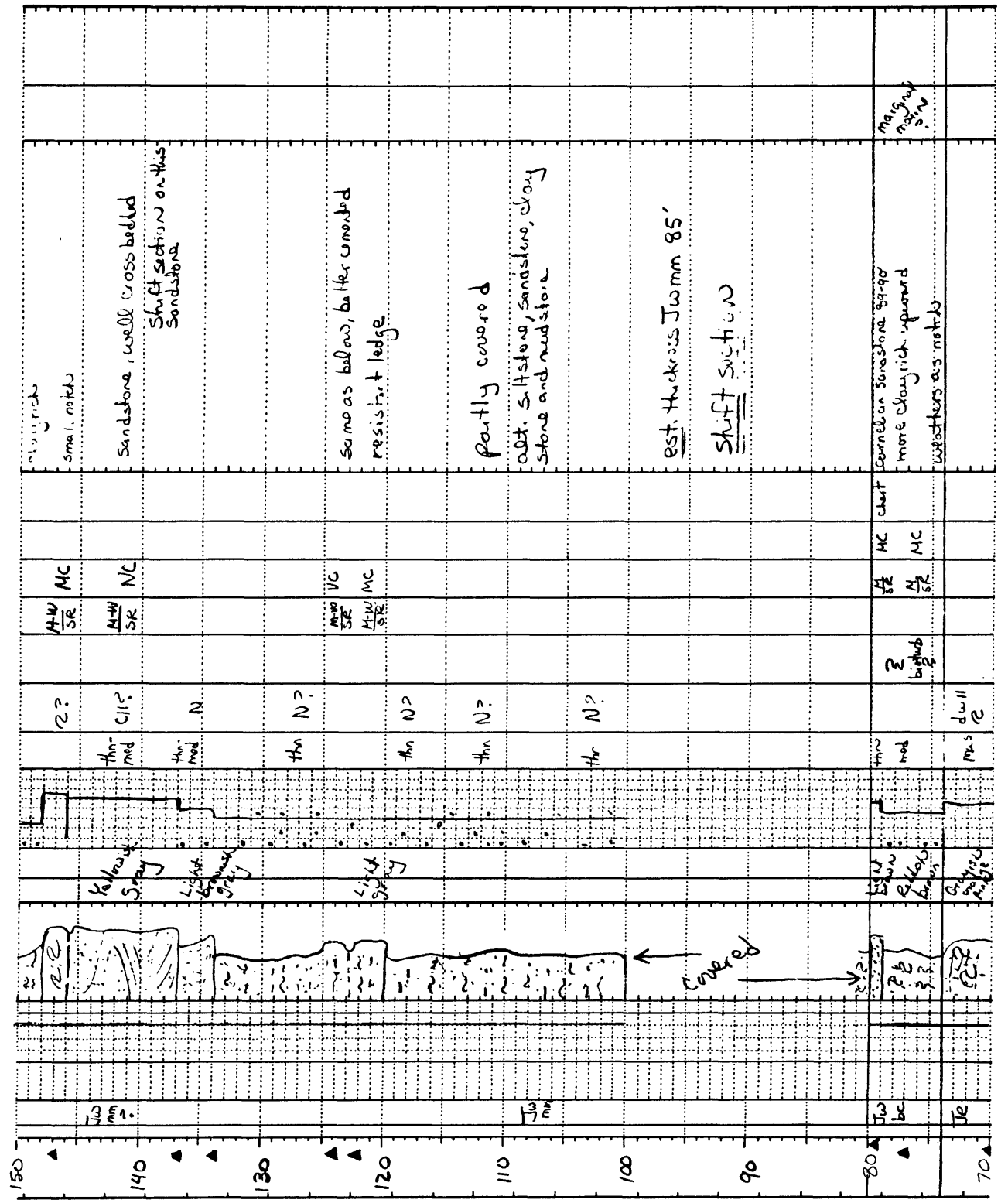


Appendix 5.-- (cont.)

LOCATION Dolores River Sec. 2 T. 39N R. 14W

STATE Colorado COUNTY Montezuma (Stoner 7.5' Quad.)

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

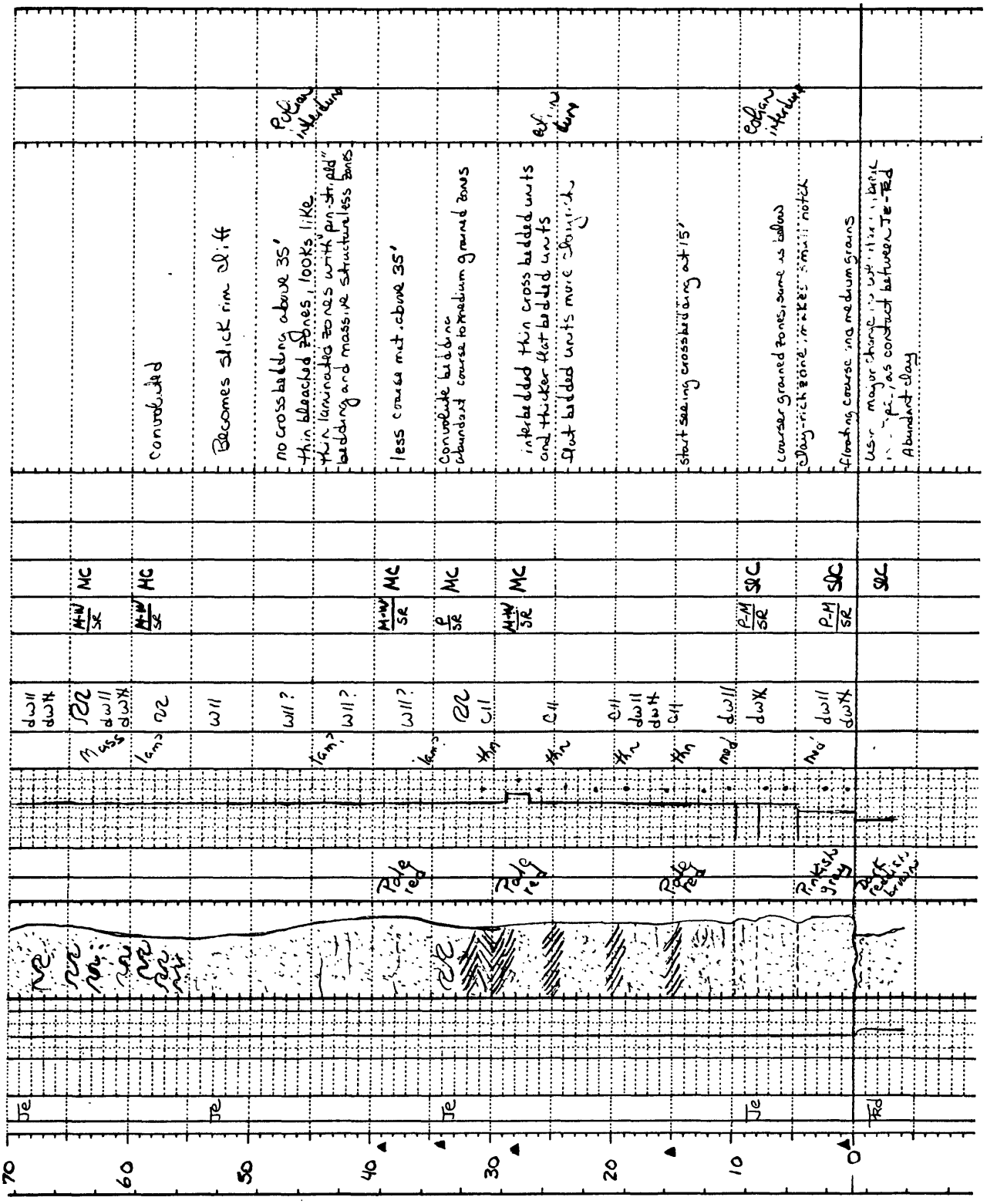


Appendix 5.-- (cont.)

LOCATION Dolores River Sec. 6 T. 39N R. 13W

STATE Colorado COUNTY Montezuma (Stoner 7.5' Quad.)

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

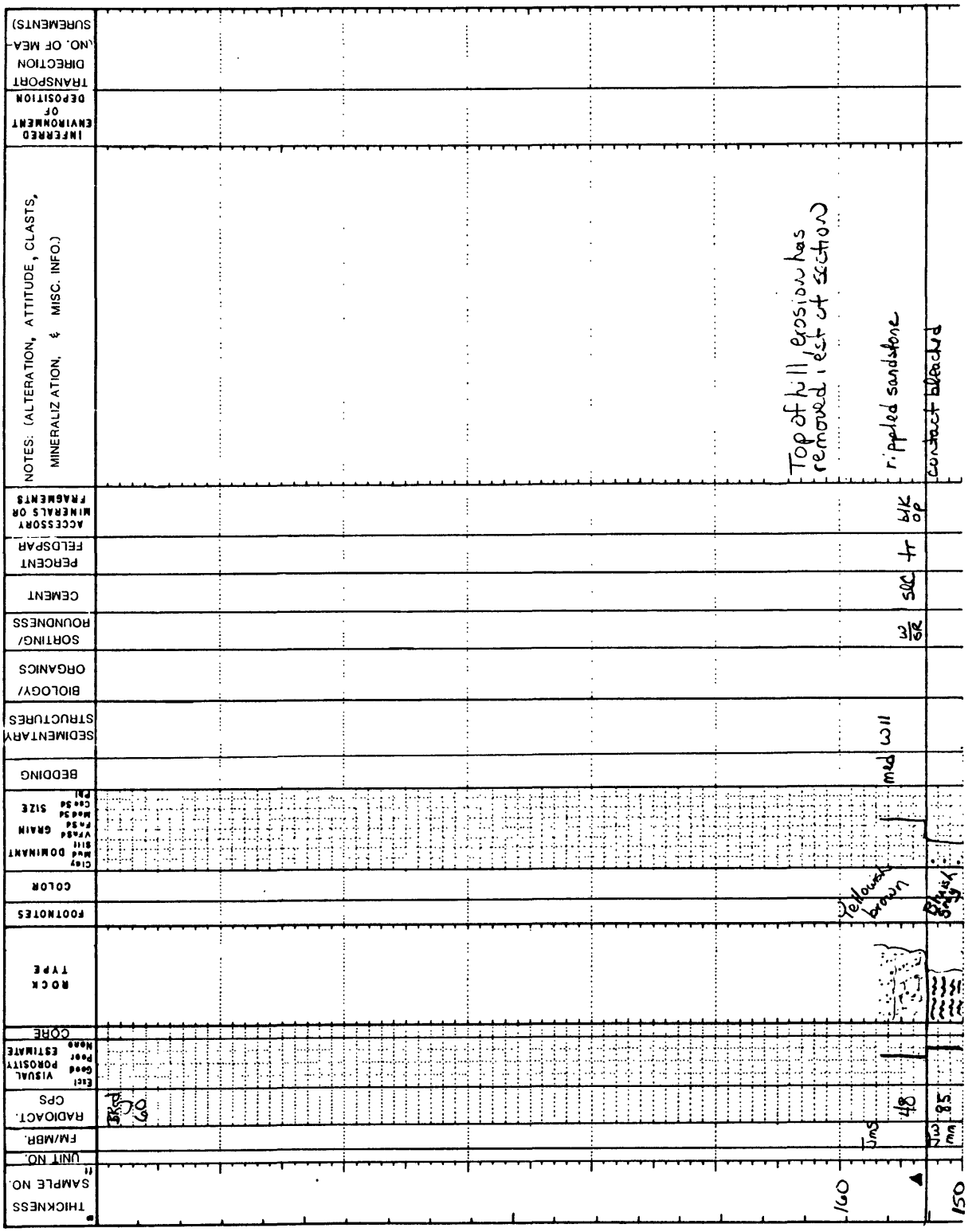


Appendix 5.-- (cont.)

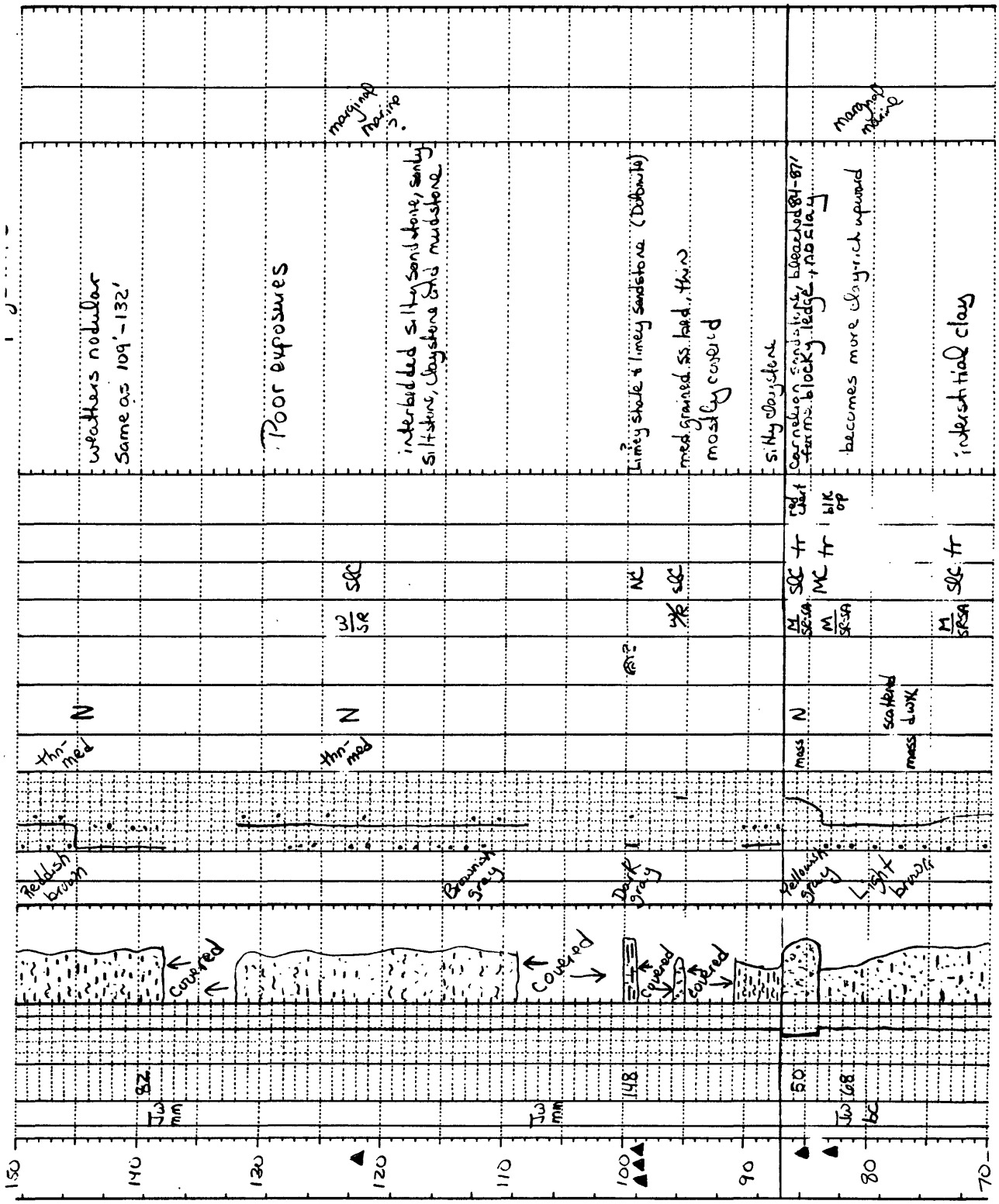
LOCATION Fall Creek 1 Sec25 T.43N R.11W QUADRANGLE (7.5') Little Cone

STATE Colorado COUNTY San Miguel DATE 7/83

LAT.-LONG. GEOL.



Appendix 6.-- Fall Creek 1 section.

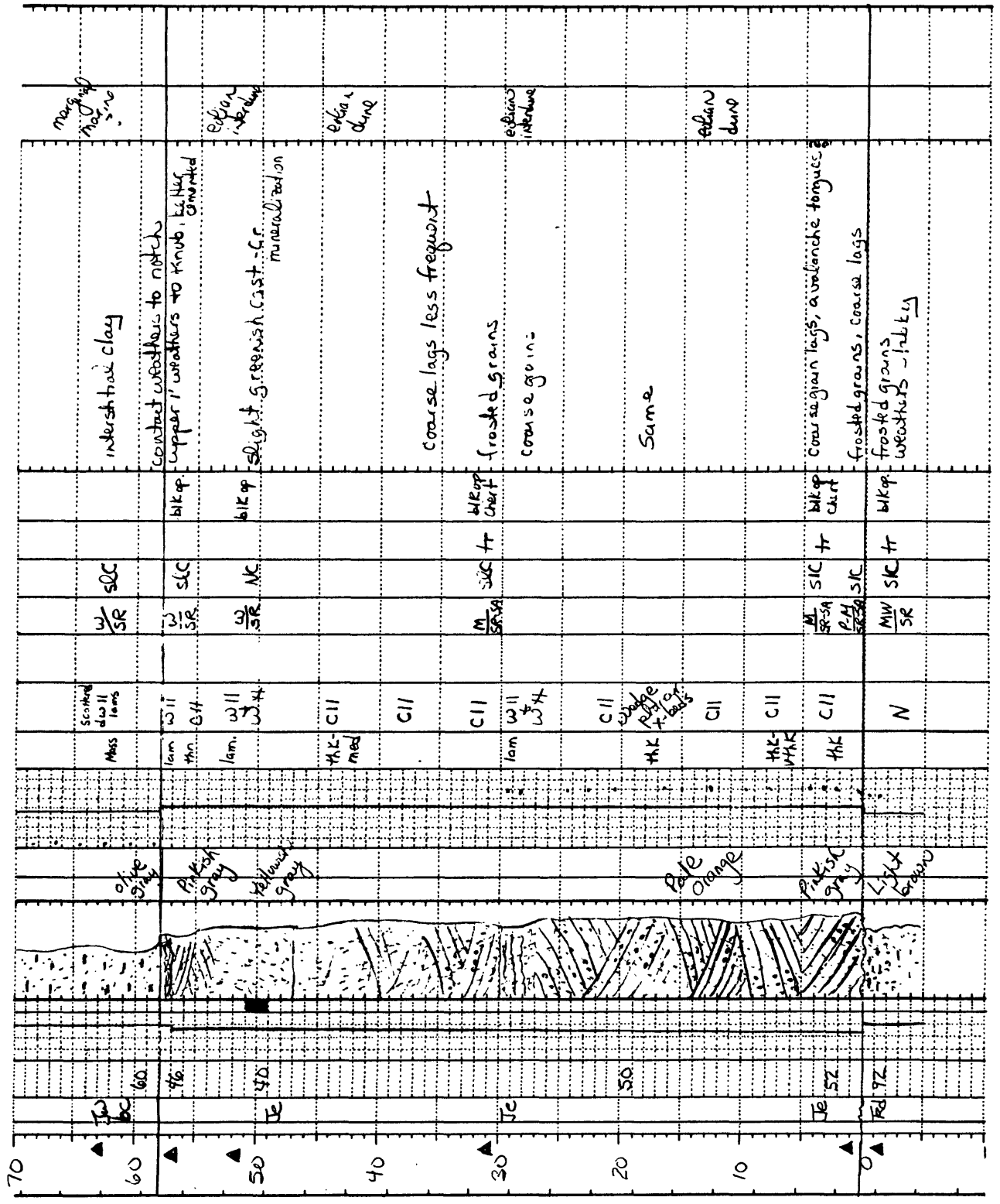


Appendix 6.-- (cont.)

LOCATION Fall Creek 1 Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

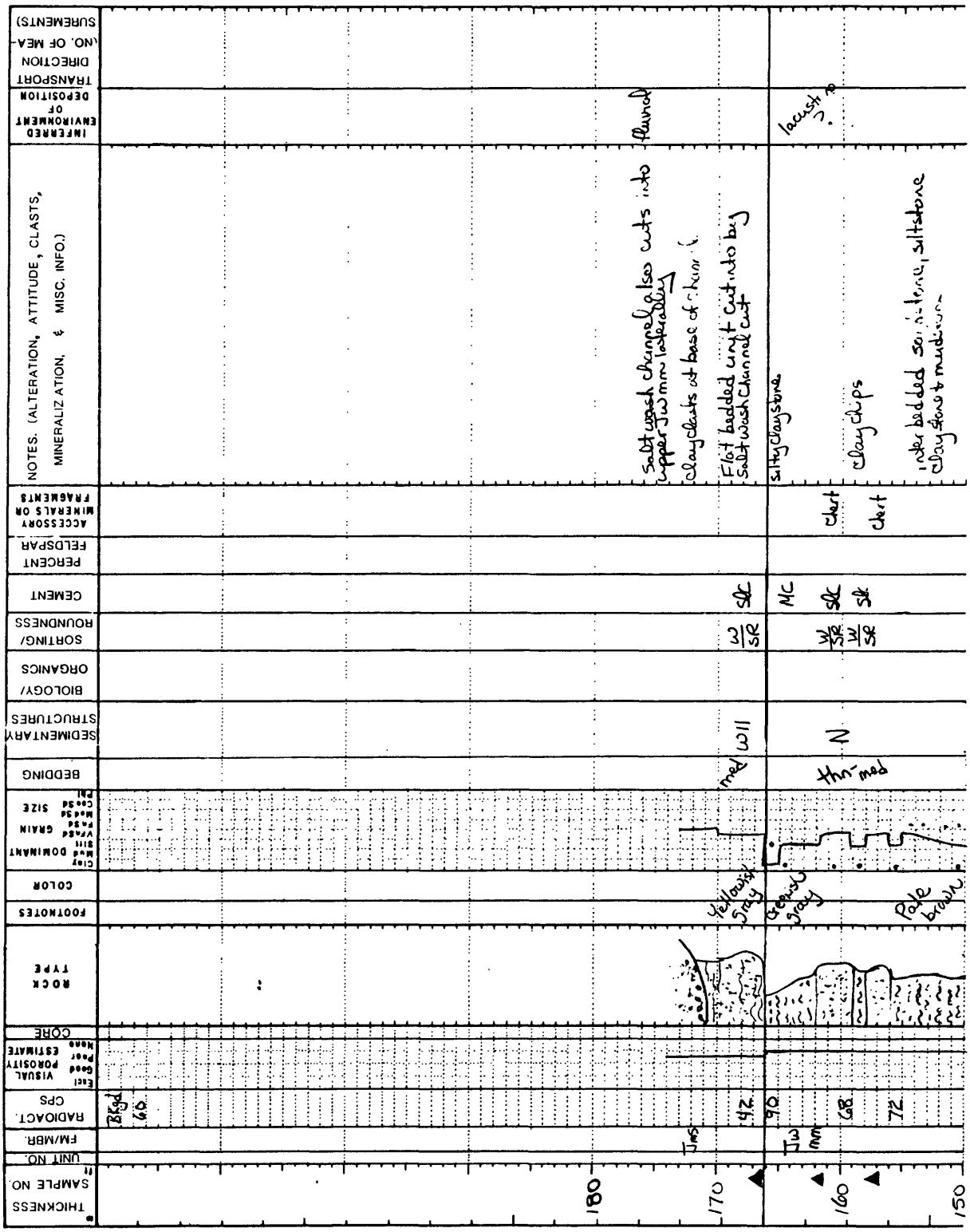


Appendix 6.-- (cont.)

LOCATION Fall Creek 2 Sec. 18 T. 43N R. 10W QUADRANGLE (7.5') Little Cone

STATE Colorado COUNTY San Miguel DATE 8/83

LAT.-LONG. GEOL.

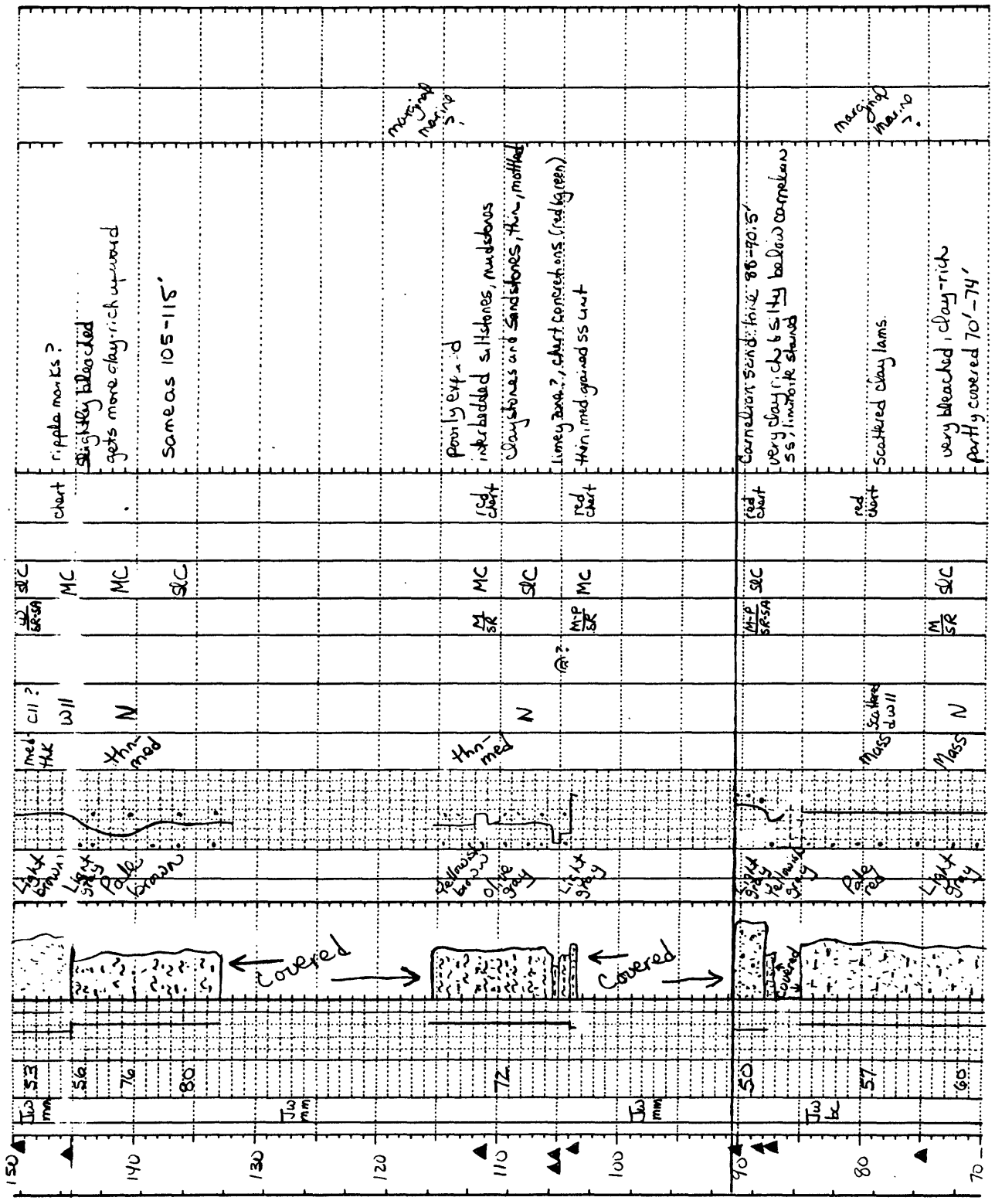


Appendix 7.-- Fall Creek 2 section.

LOCATION Fall Creek 2 Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

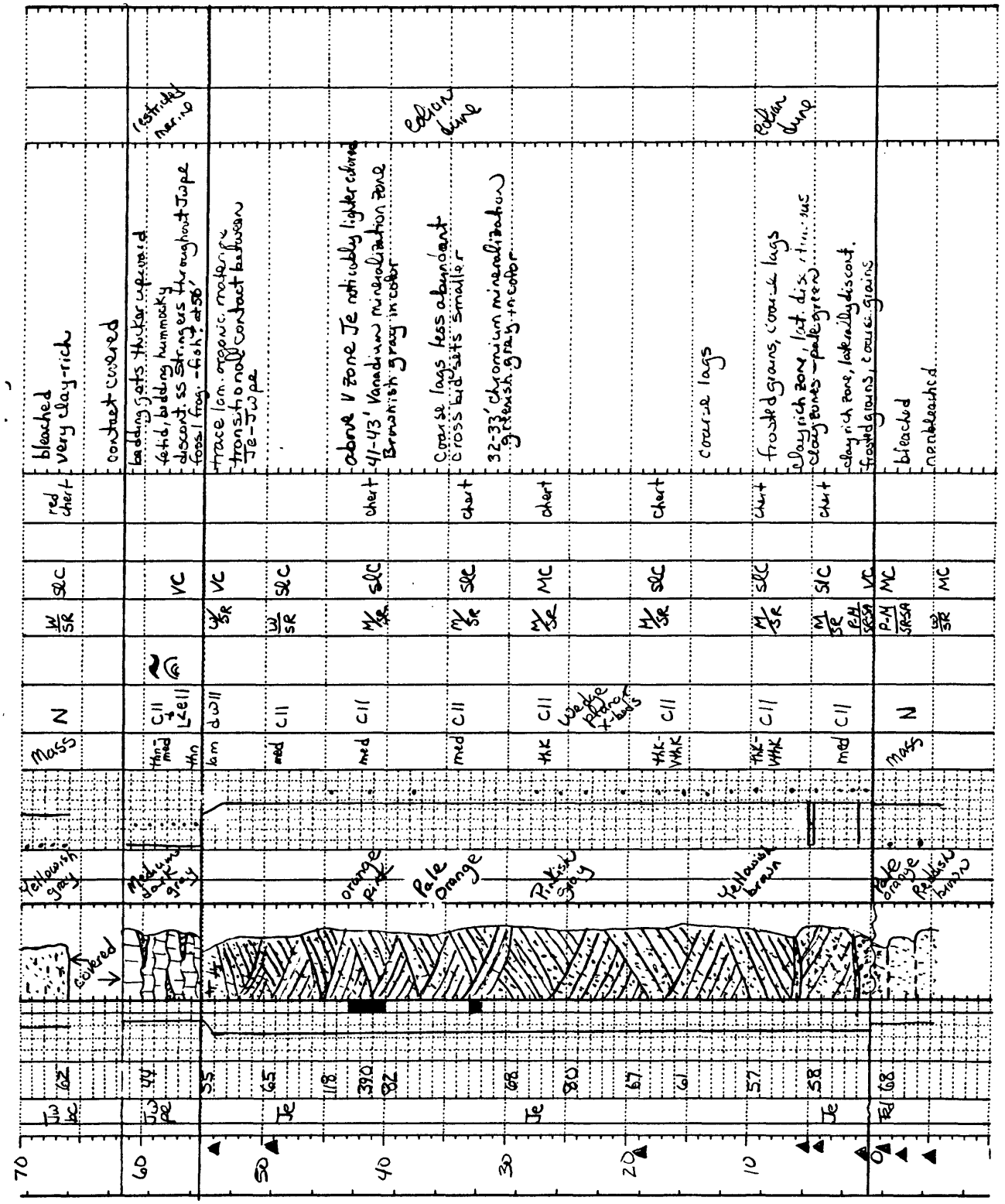


Appendix 7.-- (cont.)

LOCATION Fall Creek 2 Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

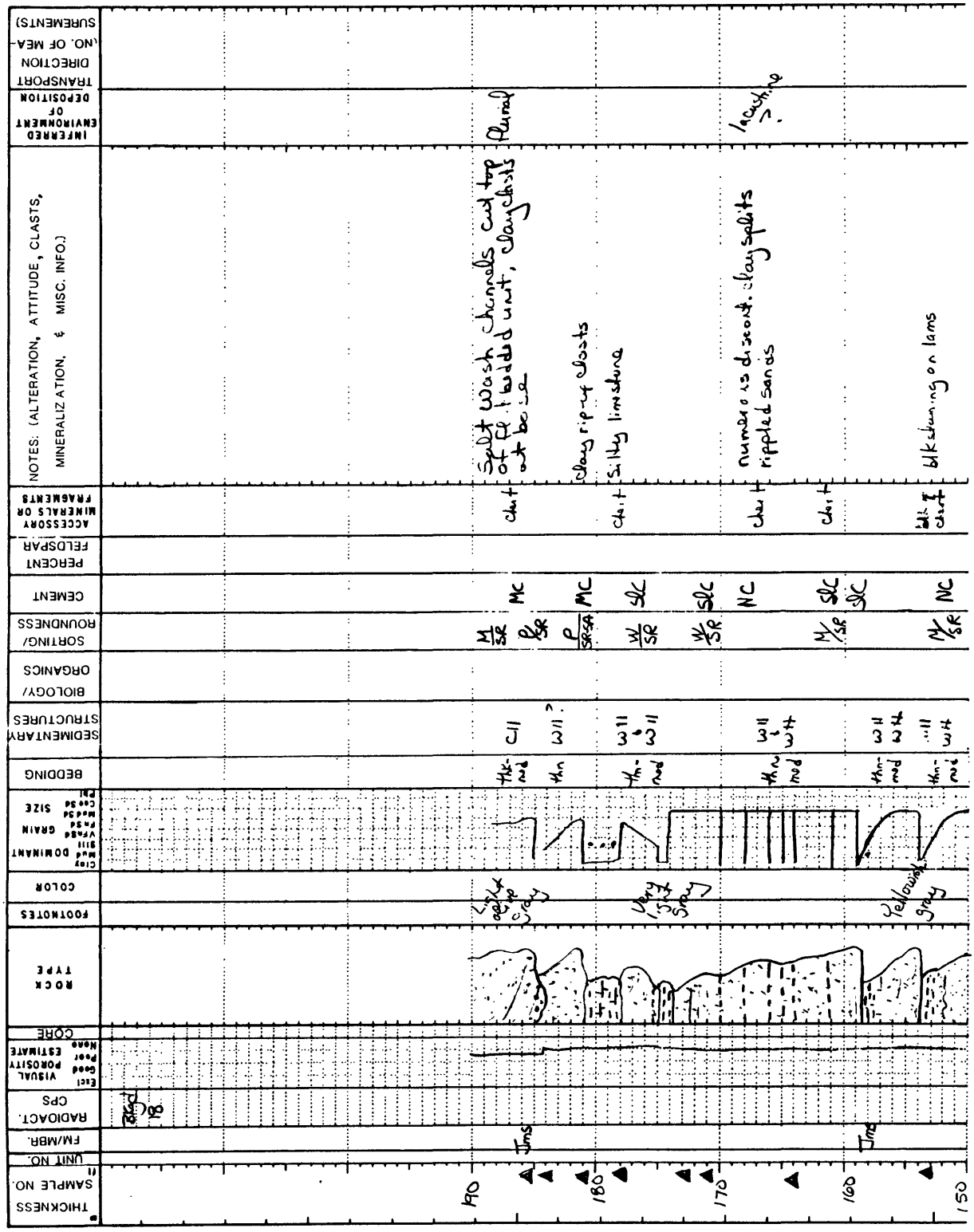


Appendix 7.-- (cont.)

LOCATION Leopard Creek Sec 24 T44N R11W QUADRANGLE (7.5') Placerville

STATE Colorado COUNTY San Miguel DATE 7/83 & 9/84

LAT.-LONG. GEOL.

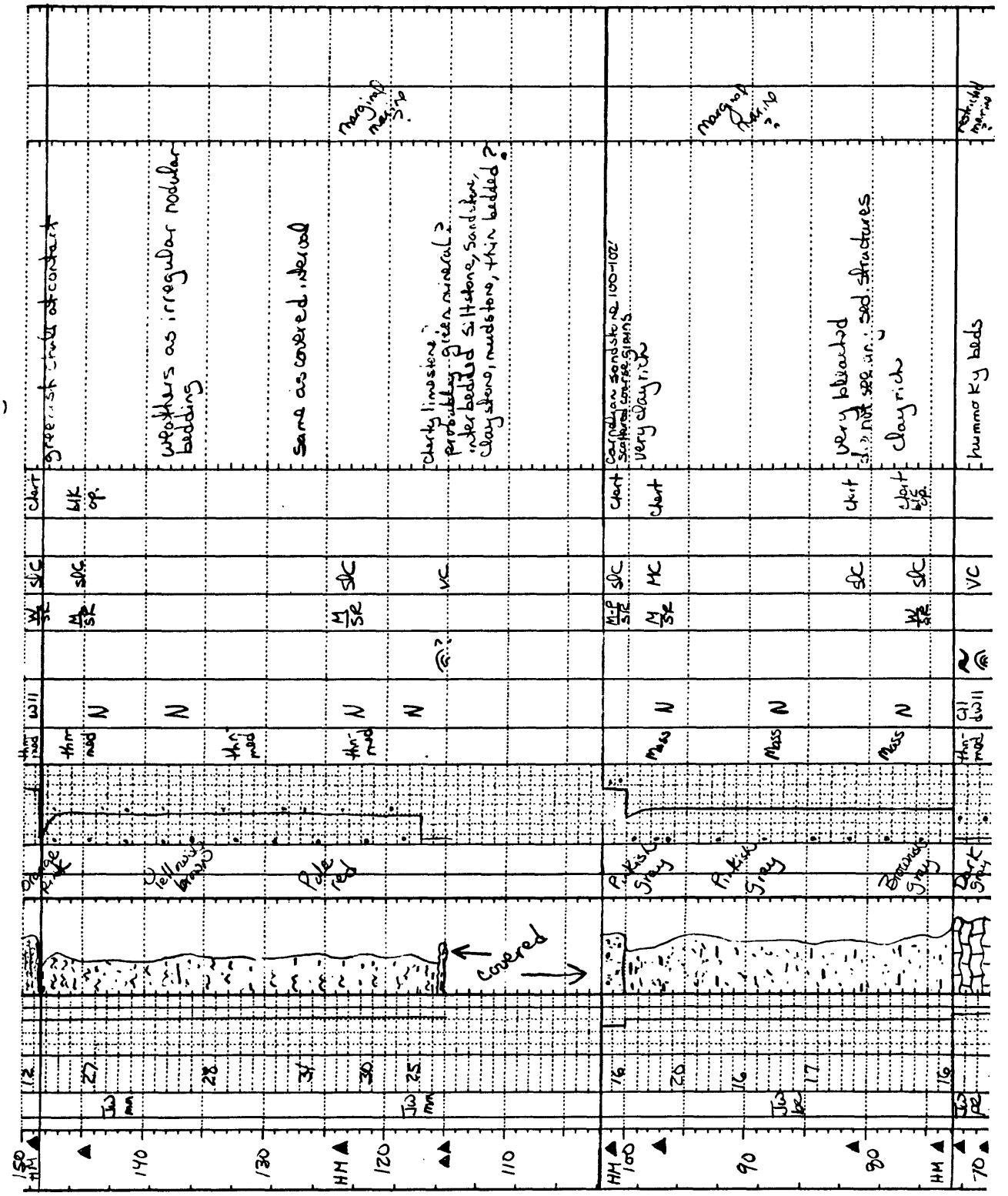


Appendix 8.-- Leopard Creek section.

LOCATION Leopard Creek Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

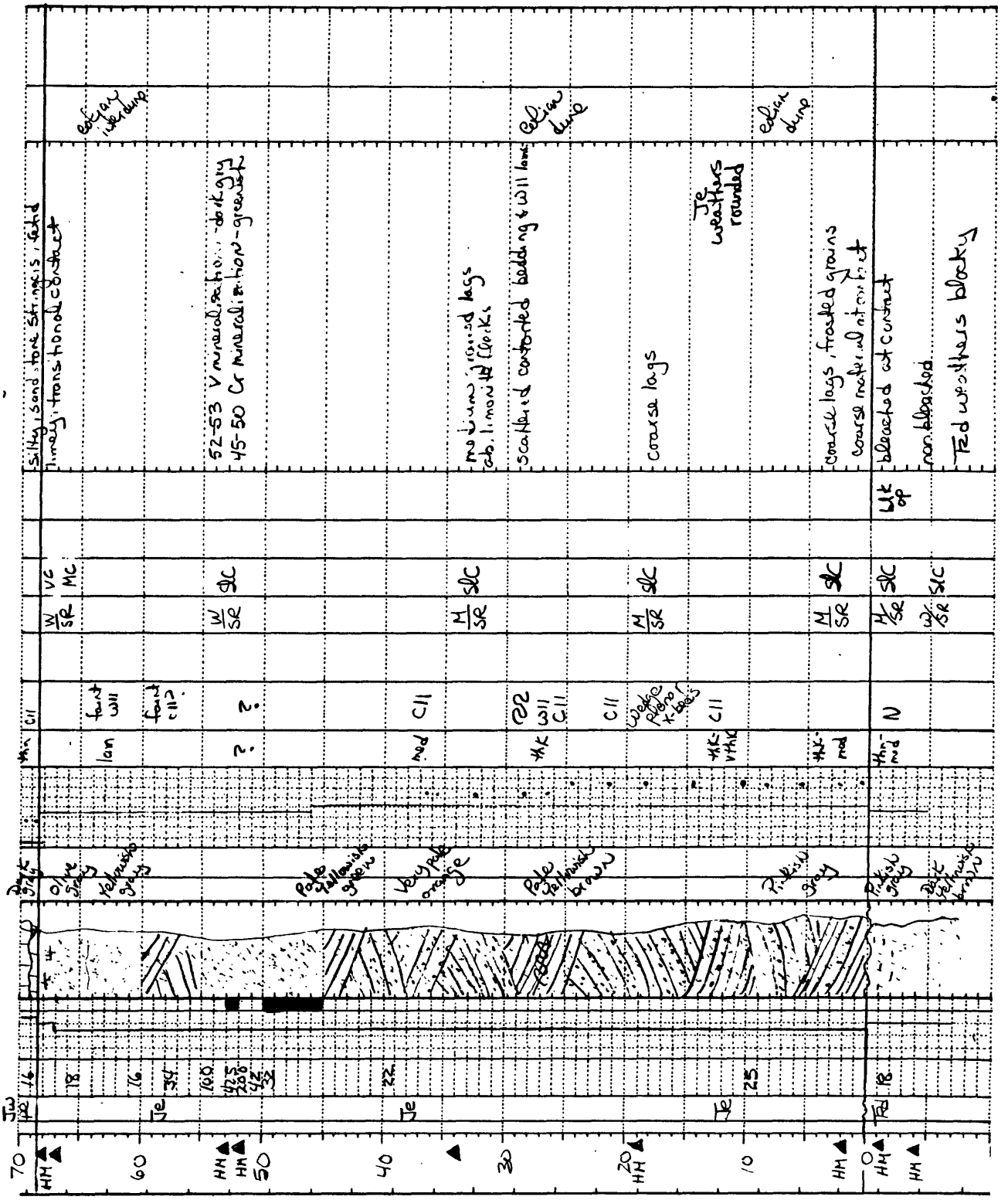


Appendix 8.-- (cont.)

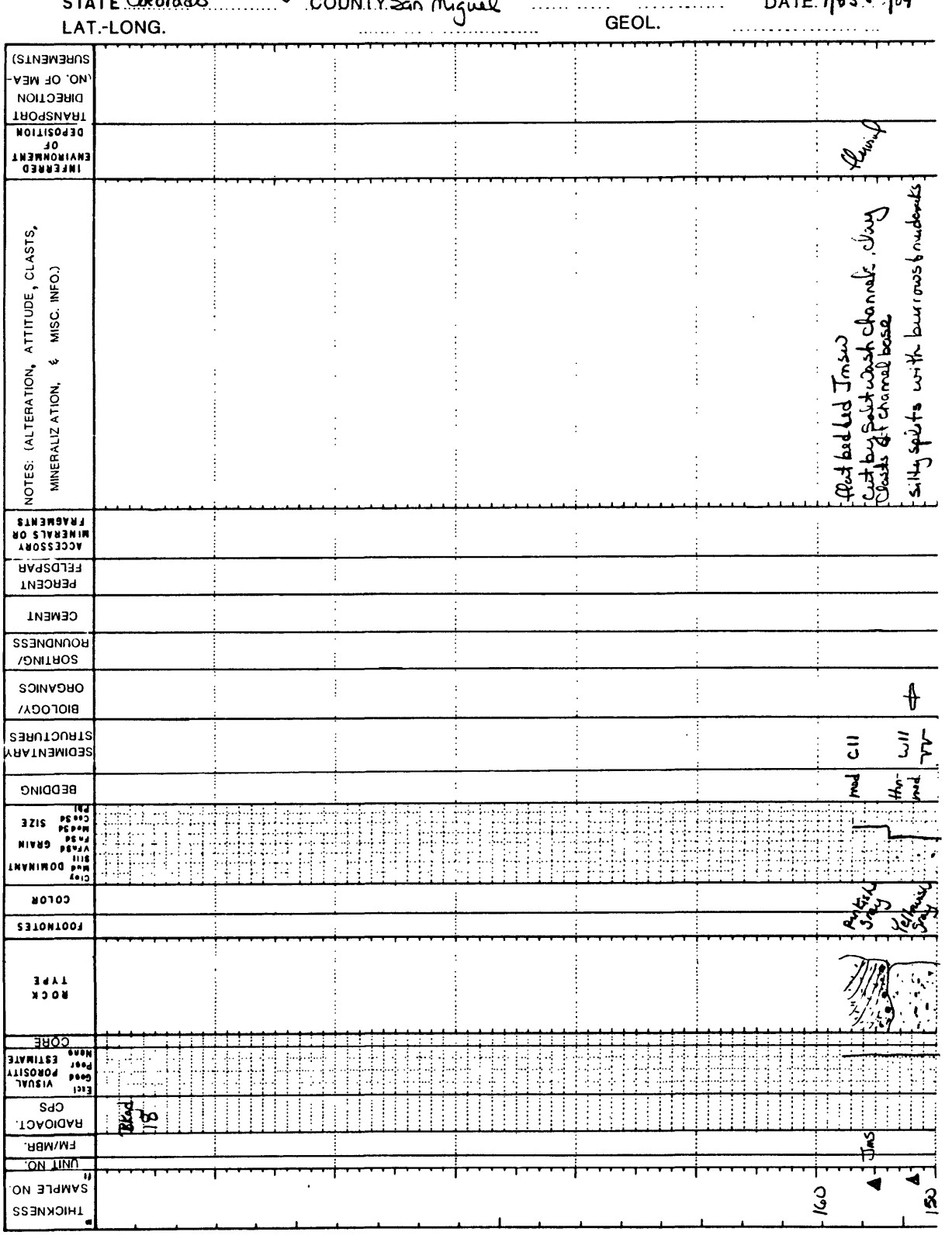
LOCATION Leopard Creek Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER



Appendix 8.-- (cont.)

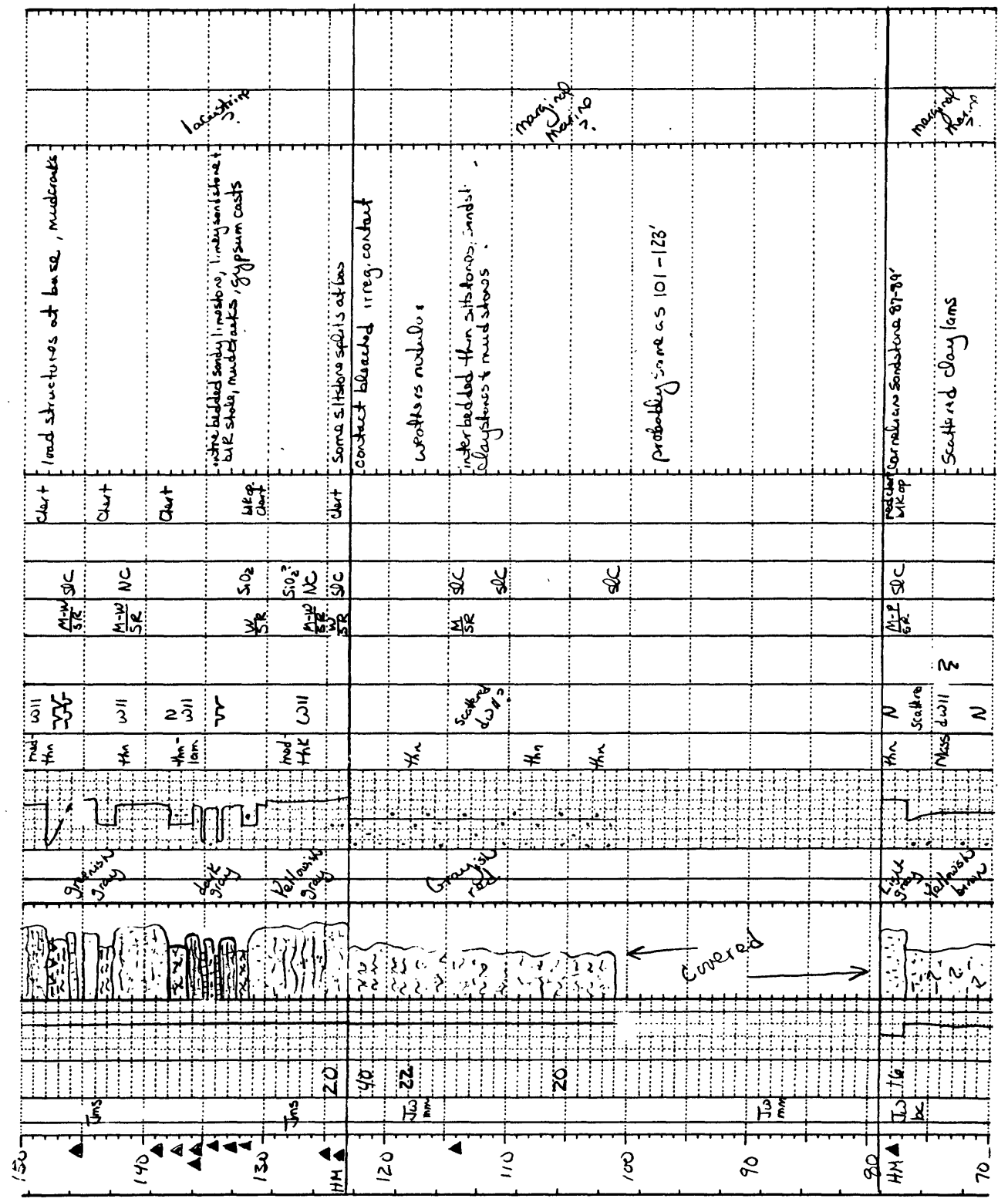


Appendix 9.-- San Miguel Canyon section.

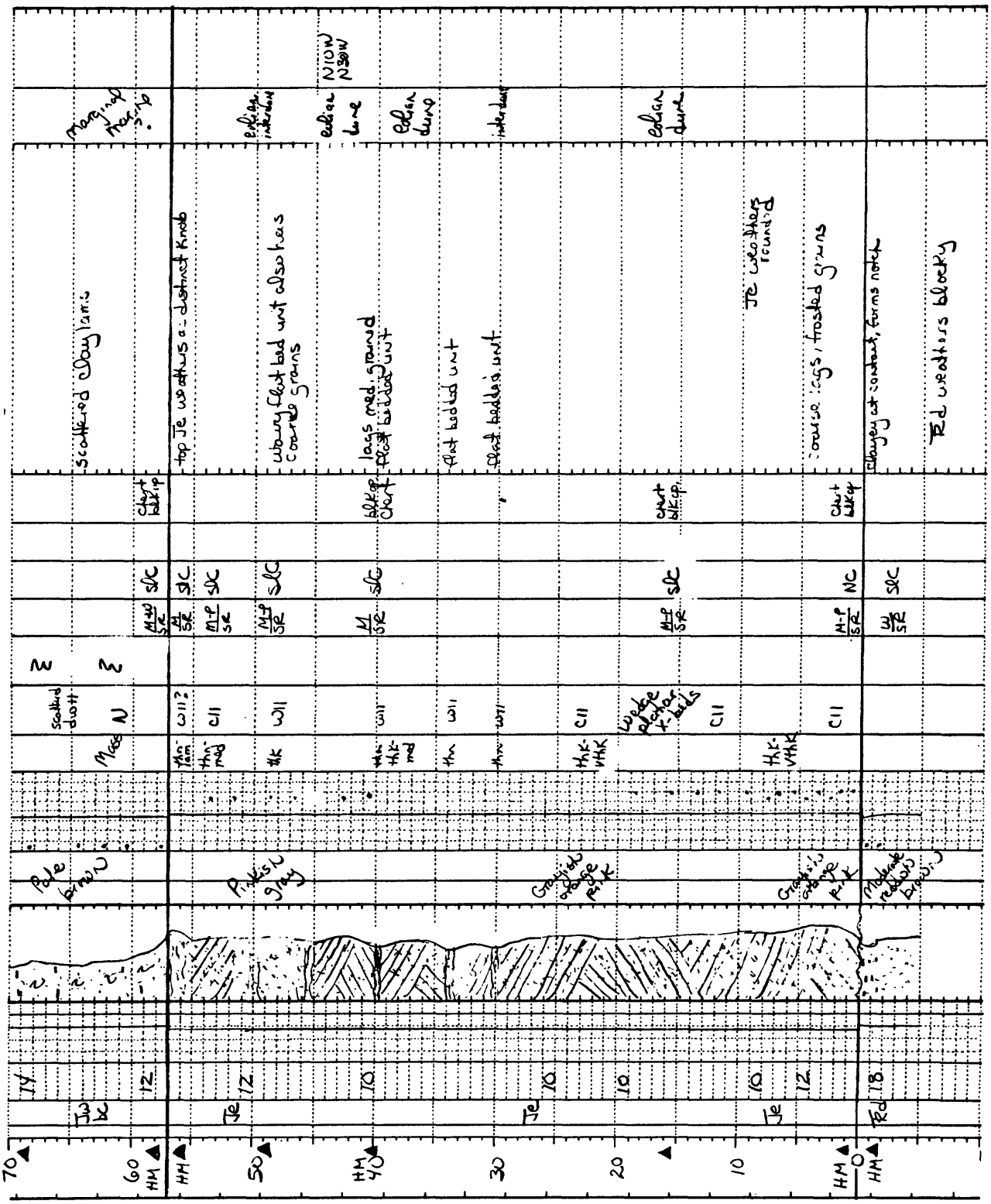
LOCATION San Miguel Canyon Sec. T. R.

STATE COUNTY

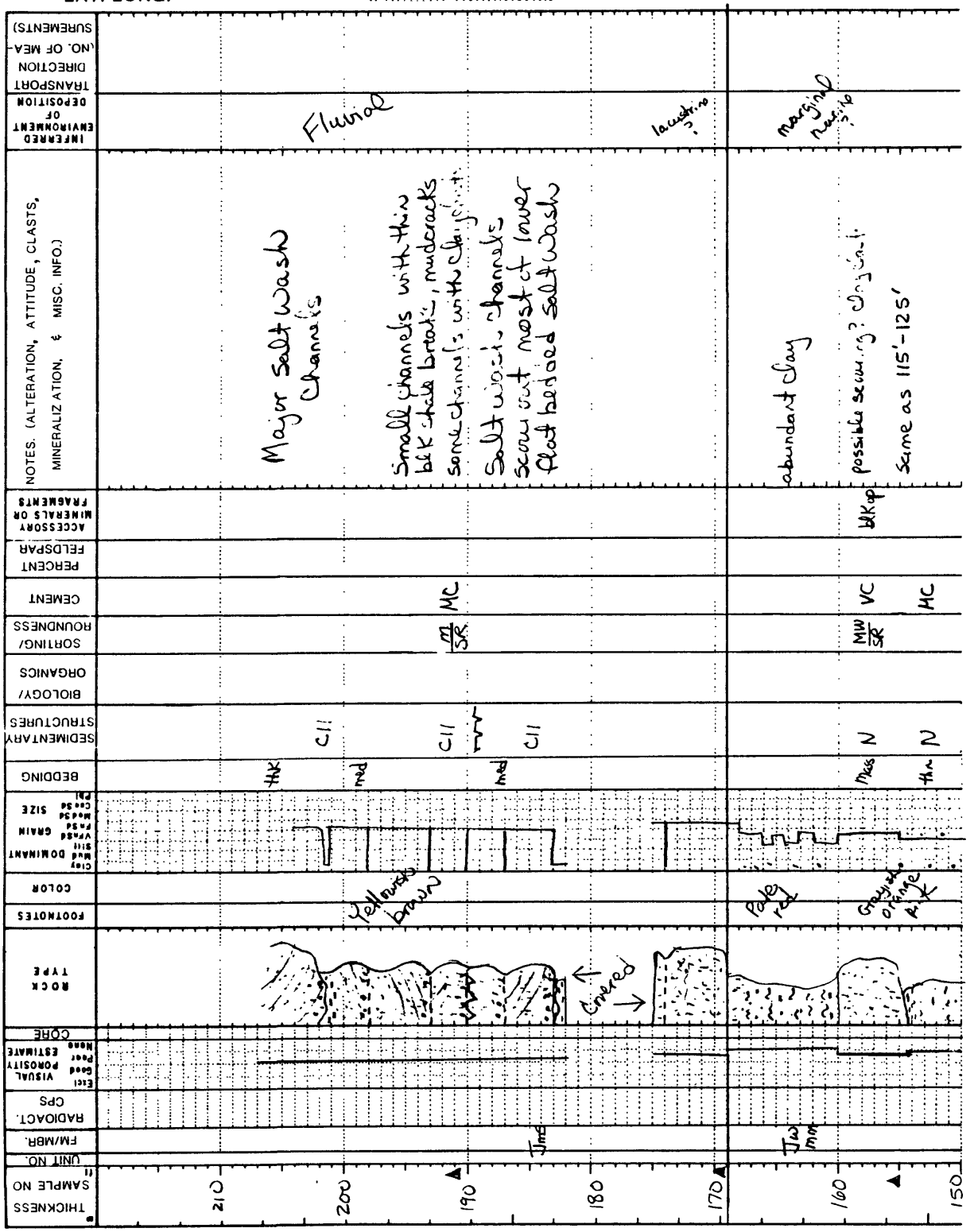
U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER



Appendix 9.-- (cont.)



Appendix 9.-- (cont.)

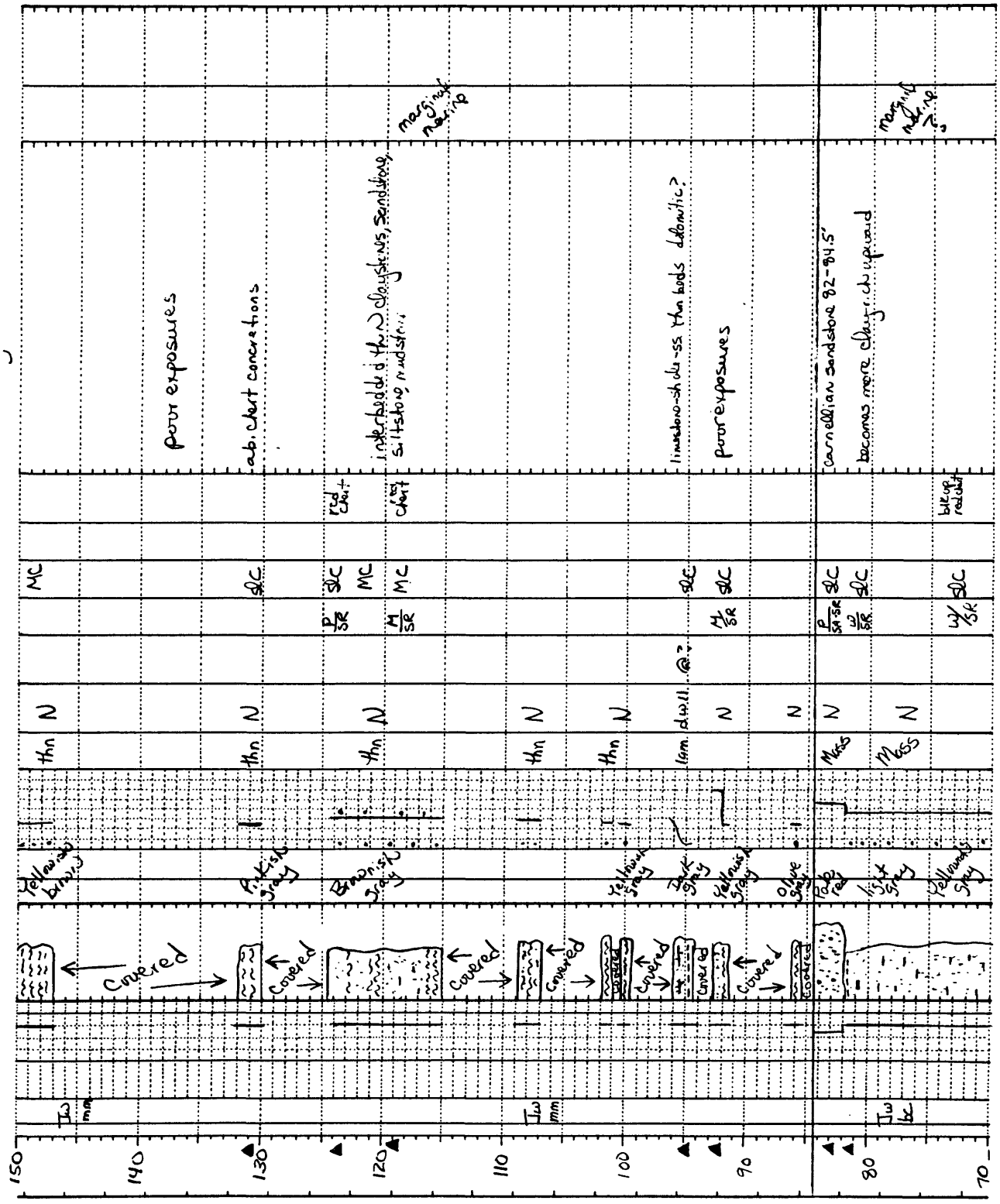


Appendix 10.-- Sawpit section.

LOCATION Saupit Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

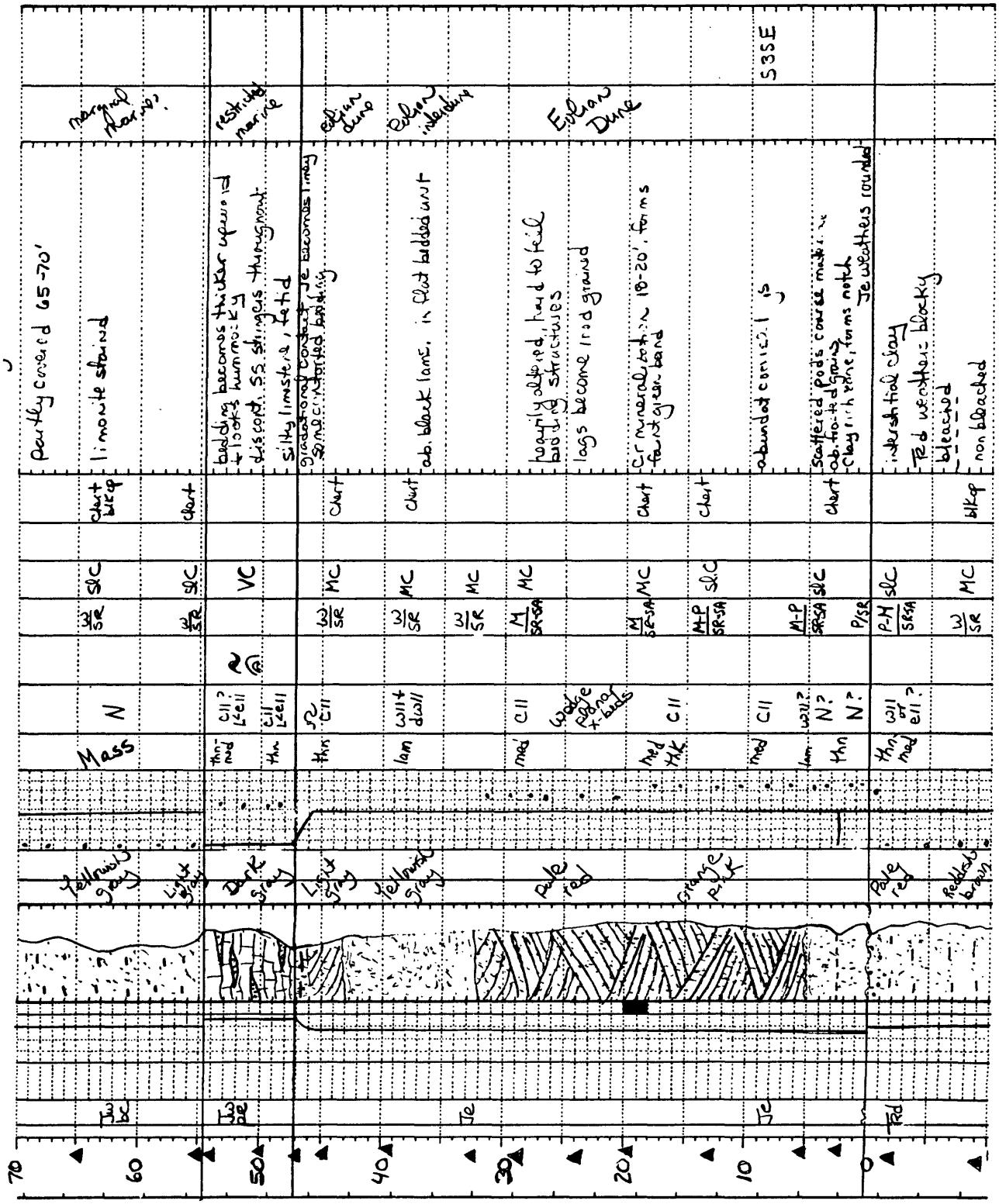


Appendix 10.-- (cont.)

LOCATION Sawpit Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER

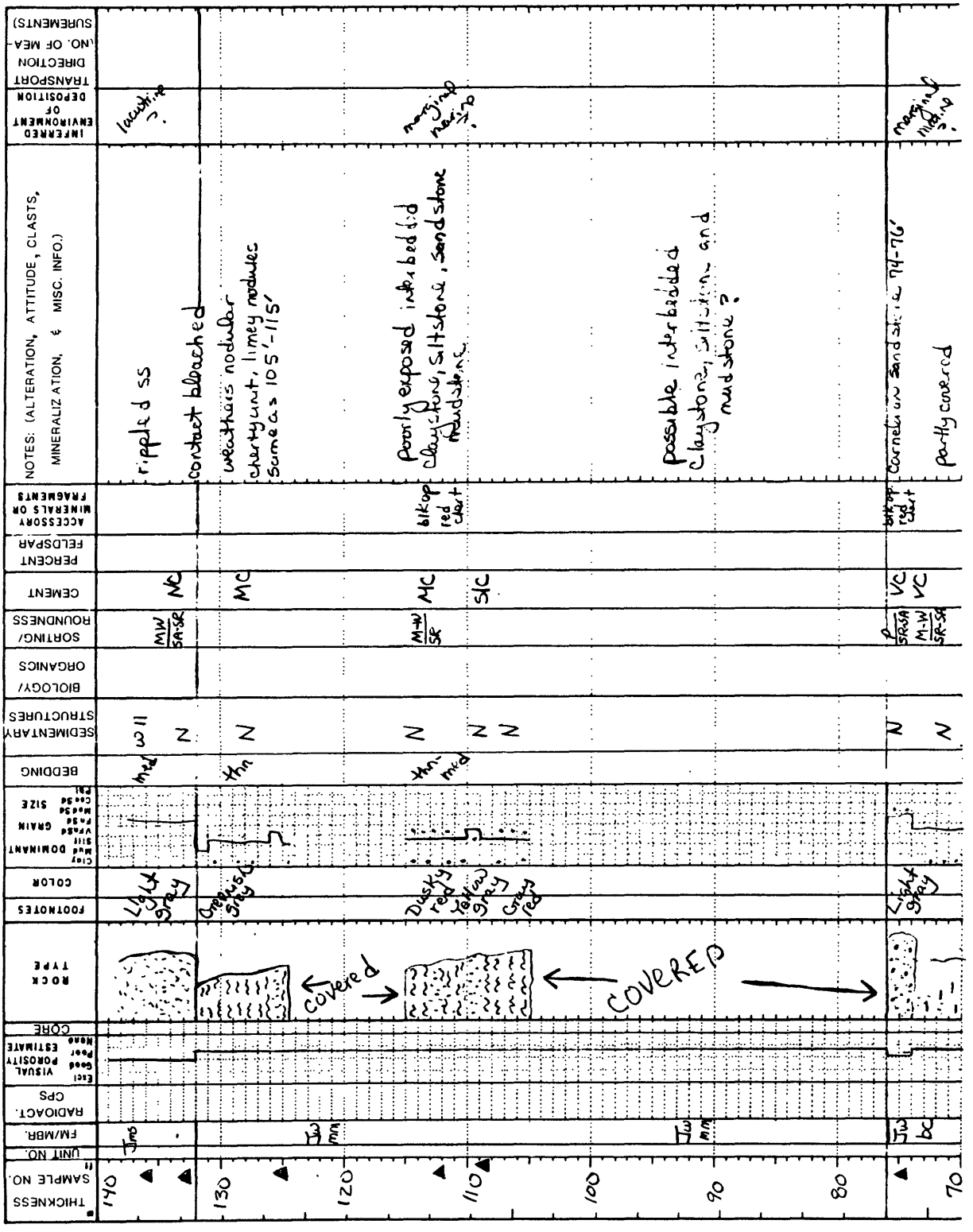


Appendix 10.-- (cont.)

LOCATION Specie Creek Sec. 6 T. 43N R. 11W QUADRANGLE (7.5') Placerville

STATE Colorado COUNTY San Miguel DATE 9/83

LAT.-LONG. GEOL.

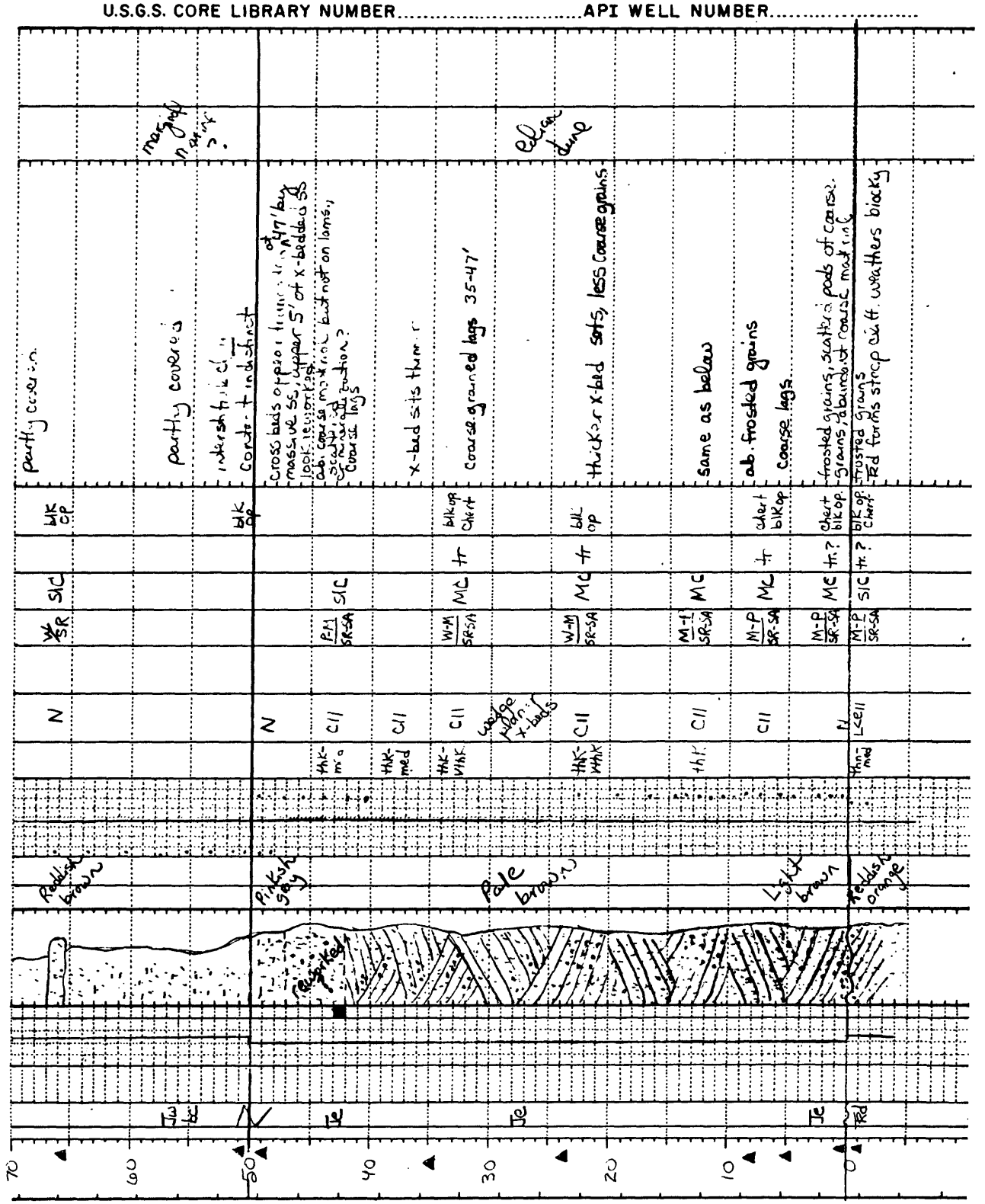


Appendix 11.-- Specie Creek section.

LOCATION Spruce Creek Sec. T. R.

STATE COUNTY

U.S.G.S. CORE LIBRARY NUMBER API WELL NUMBER



Appendix 11.-- (cont.)