UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

DESCRIPTION OF SELECTED DRILL CORES FROM THE PRECAMBRIAN SPOKANE FORMATION, BLACKTAIL MOUNTAIN DRILLING SITE, FLATHEAD COUNTY, MONTANA

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CONTENTS

ILLUSTRATIONS

CONTENTS — Continued

ILLUSTRATIONS — Continued

TABLES

INTRODUCTION

In graphic form, this report describes drill cores from ten shallow holes drilled at Blacktail Mountain, Flathead County, Montana (fig. 1). Rocks described represent the sequence of alternating argillitic green beds and argillitic purple beds which occur at the top of the Spokane Formation of the Belt Supergroup of Proterozoic Y age (fig. 2).

The holes were drilled to obtain detailed information on the succession of rock types, environments of deposition, distribution of small amounts of copper sulfides known to occur in the strata, and geochemical and mineralogic properties of the strata. The geology of the drilling site, geophysical data from the holes, and geochemical data for selected cores have been summarized in companion reports (Harrison and Reynolds, 1979; O'Connor and others, 1979; Domenico, 1979).

METHODS OF STUDY

Drill core examined for this report was slabbed through its center, parallel to its long axis, to produce slabs about 8.8 cm wide. The core is essentially continuous for the holes drilled. After slabbing the core was first examined for megascopic properties, then examined microscopically with a binocular microscope at magnifications ranging from about 10x to 400x, to identify other properties such as grain size, mineralogy, texture and fabric, and small-scale bedding characteristics. Cut surfaces of the core were moistened with water for examination; colors described are those of the wet rock.

Identification of mineral grains and cement types was made visually through the microscope or by using mechanical or chemical tests. To dis-

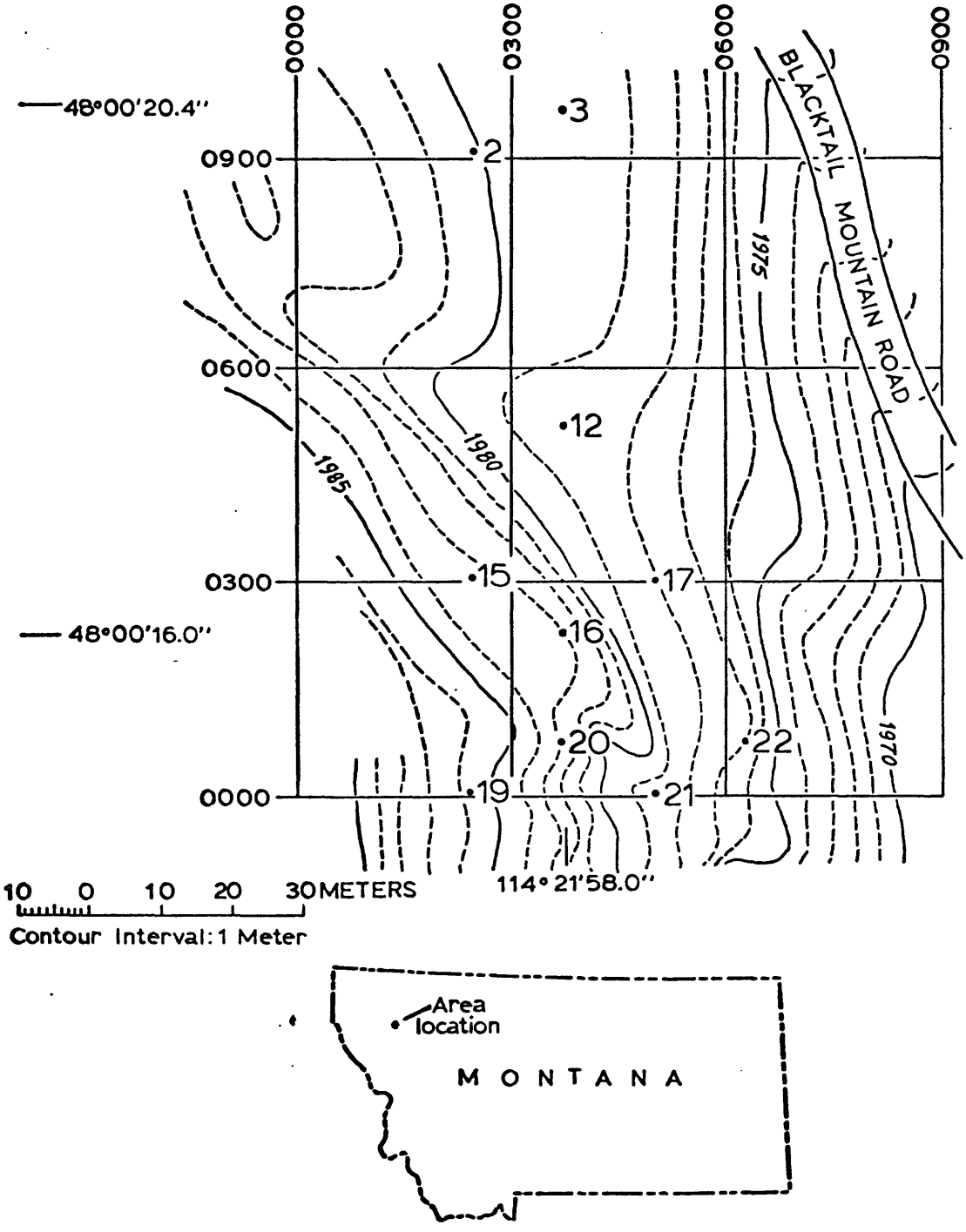


FIGURE 1. — Index map showing topography of Blacktail Mountain drilling site, location of drill holes from which drill core is described in this report, and reference grid for the drilling site. Topography by J. J. Connor, 1978.

FORMATION	UNIT SYMBOL USED ON CORE DESCRIPTION	DOMINANT ROCK TYPES	UNITS DESCRIBED IN THIS REPORT, BY DRILL HOLE NUMBER									
			BT-2	BT-3	BT-12	BT-15	BT-16	BT-17	BT-19	BT-20	BT-21	BT-22
Empire Formation (lower part)	Ye	Light greenish-gray argillitic siltite and argillite										
Spokane Formation (upper part)	Ysp_6	Grayish-purple siltite and argillitic siltite										
	Ysg_5	Greenish-gray siltite and argillitic siltite										
	Ysp_5	Purplish-gray siltite and minor argillitic siltite										
	Ysg_4	Greenish-gray argillitic siltite and siltite										
	Ysp_4	Grayish-purple siltite										
	Ysg_3	Greenish-gray argillitic siltite and siltite, minor quartzite										
	Ysp_3	Grayish-purple siltite and argillitic siltite										
	Ysg_2	Greenish-gray siltite, argillitic siltite, argillite										
	Ysp_2	Grayish-purple argillitic siltite and siltite										
	Ysg_1	Greenish-gray argillitic siltite, siltite, minor quartzite										
	Ysp_1	Grayish-purple siltite and argillitic siltite										

FIGURE 2. — Stratigraphic sequence at Blacktail Mountain, Montana, drilling site and symbols used on core descriptions for units of the Spokane Formation

tinguish calcite from dolomite, 0.1 N hydrochloric acid, calibrated first for reaction on carbonate rocks of known composition, was applied to the dry rock surface. Estimates of the kind and quantity of carbonate cement present were made by judging the relative speed and vigor of effervescence of the minerals in the dilute acid. Grain-size and porosity estimates were made through the binocular microscope by comparison to commercially available standards.

Table 1 summarizes abbreviations used in the graphic descriptions. Tables 2-7 summarize symbols and standards used on the graphic logs and are arranged in their order of occurrence on log headings. Pages of descriptions can be assembled in succession to form continuous strip logs of the intervals cored.

ACKNOWLEDGEMENTS

Richard E. Van Loenen and David J. Lidke slabbed much of the core described here. Captain Eugene Nadeau, Commander, Kalispell Air Force Base, Montana, kindly permitted use of a building at the Base for core slabbing and study while drilling was in progress. I am grateful to Charles Curry and Donald Blair of the Engineering Office at the Base for solving several technical problems in order to make handling and slabbing the core more efficient. J. William Hasler, U.S. Geological Survey, supervised the drilling. Jack E. Harrison, with intermittent help from Joan P. Harrison, worked patiently at the drilling site to ensure that the core was collected carefully, boxed in the correct sequence, and properly labelled, thus minimizing difficulties in handling and logging during examination.

REFERENCES CITED

Domenico, J. A., 1979, Semiquantitative spectrographic analyses from selected drill cores, Blacktail Mountain, Montana: U.S. Geol. Survey Open-file Rept. 79-939, 33 p.

Geological Society of America, 1963, Rock-color chart: 10 p.

Harrison, J. E., and Reynolds, M. W., 1979, Preliminary geology of the Blacktail Mountain drilling site, Flathead County, Montana: U.S. Geol. Survey Open-file Rept. 79-938, 30 p.

Maher, J. C., 1964, The composite interpretive method of logging drill cuttings, 2nd ed.: Oklahoma Geol. Survey Guidebook 14, 48 p.

O'Connor, L. J., Smith, B. D., and Scott, J. H., 1979, Geophysical data from the Blacktail Mountain drilling site, Montana: U.S. Geol. Survey Open-file Rept. 79-940, 6 p.

TABLE 1. – Abbreviations for words used in descriptions of drill cores (Modified from Maher, 1964)

About	abt	Cross-stratified	xstrat
Above	abv	Cryptocrystalline	crpxl
Abundant	abnt	Crystal	xl
Aggregate	agg	Crystalline	xln
Altered, altering	alt	Dark	dk
Amorphous	amor	Decrease, decreasing	decr
Amount	amt	Dendritic	dend
And	&	Dense	dns
Angular, angle	ang, ∠	Determine	dtrm
Anhedral	anhed	Detrital, detritus	dtrl
Anhydrite, anhydritic	anhy	Diameter	dia
Aphanocrystalline	aphoxl	Difference	dif
Apparent	apr	Disrupted	disrp
Appears	aprs	Disseminated	dism
Approximate, approximately	aprox	Dolocast, dolocastic	dolc
Argillite, argillaceous	arg	Dolomite, dolomitic	dol
At	@	Dolomold, dolomoldic	dolmd
Average	av	Druse, drusy	drsy
Band, banded	bnd	Embedded	embd
Bed	bd	Enlarged	enl
Bedded	bdd	Equivalent	equiv
Bedding	bdg	Euhedral	euhed
Biotite	biot	Evaporitic	evap
Black	blk	Expose, exposed, exposure	exp
Block, blocky	blky	Extrusion, extrusive	extr
Blue, bluish	bl	Fault	flt
Breccia, brecciated	brec	Feldspar, feldspathic	fld
Bright	bri	Ferruginous	Fe
Brittle	brit	Fine, finely	f
Brown	brn	Fissile	fis
Calcite, calcareous	calc	Foliated	fol
Caving	cav	Formation	fm
Cement, cemented	cmt	Fracture, fractured	frac
Center, centered	cntr	Fragment, fragmental	frag
Chlorite	chl	General	gen
Clastic	clas	Good	g
Clay, clayey	cly	Grade, grades, graded	grd
Claystone	clyst	Grading	grdg
Coarse, coarsely	c	Grain, grained	gr
Color, colored	col	Granular	gran
Common	com	Granule	grnl
Concretion, concretionary	conc	Gravel	gvl
Conglomerate, conglomeratic	cgl	Gray	gy
Contact	ctc	Green	gn
Contorted	cntrt	Gritty	grty
Covered	cov	Gypsum, gypsiferous	gyp
Crenulated	cren	Hackly	hky
Crossbedded	xbd	Hard	hd
Crossbedding	xbdg	Heavy	hvy
Cross-laminated	xlam	Hematite, hematitic	hem

TABLE 1. — Abbreviations for words used in descriptions of drill cores — Continued

High	hi	Middle	mid
Horizontal	hztl	Mineral, mineralized	mnrl
Imbedded	imbd	Minimum	min
Impression	imp	Minor	mnr
Increase, increasing	incr	Minute	mnut
Indistinct	indst	Moderate	mod
Indurated	ind	Mottled, mottling	mot
Interbedded	intbd	Mudstone	mdst
Intercalated	intcl	No, non-	n.
Intercrystalline	intxl	Nodule	nod
Interfingered	intfr	Normal	nor
Intergranular	intgran	Numerous	num
Intergrown	intgwn	Object	obj
Interlaminated	intlam	Olive	olv
Interstitial	intstl	Oxidized	ox
Interval	intv	Part, partly	pt
Intraformational	intfm	Parting	ptg
Iron	Fe	Patch, patchy	pch
Ironstone	Fest	Pearl, pearly	prly
Irregular	ireg	Pebble	pbl
Jointed	jtd	Pebbly	pbly
Joints	jts	Pellet, pelletal	pel
Laminated	lam	Permeability	perm
Large, larger	lrg	Pink	pk
Leached	lchd	Pinpoint	p-p
Lentil, lenticular	len	Pitted	pit
Light, lighter	lt	Plagioclase	plag
Limestone	ls	Plastic	plas
Limonite, limonitic	lim	Platy	plty
Limy	lmy	Poor, poorly	p
Lithic, lithology	lith	Porosity, porous	por
Little	ltl	Possible, possibility	pos
Local	loc	Predominate, predominantly	pred
Long	lg	Preserved, preservation	pres
Loose	lse	Primary	prim
Lower	low	Prism, prismatic	pris
Lumpy	lmpy	Probable, probably	prob
Magnetite, magnetic	magn	Prominent, prominently	prom
Massive	mas	Pseudo-	psdo
Material, matter	mat	Purple	purp
Matrix	mtx	Pyrite, pyritized	py
Maximum	max	Quartz	qtz
Median	mdn	Quartzite	qtzt
Medium	m	Quartzitic	qtzc
Member	mbr	Radiate, radiating	rad
Metamorphic	meta	Random	ran
Mica, micaceous	mica	Range, ranging	rng
Microcrystalline	micxl	Rare	rr
Microcrosslaminae	micxlam	Regular	reg

TABLE 1. — Abbreviations for words used in descriptions of drill cores — Continued

Remains, remnant	rmn	Stippled	stip
Replaced, replacement	repl	Stone	st
Residue, residual	resd	Strata, stratified	strat
Reverse	rev	Streak	str
Rhomb, rhombic	rhmb	Striated	stri
Rock	rk	Stringer	strg
Round, rounded	rd	Structure	struc
Rubbly	rbly	Subangular	sbang
Sample	spl	Subhedral	sbhed
Sand	sd	Subrounded	sbrd
Sandstone	ss	Surface	surf
Sandy	sdy	Tabular	tab
Scarce	scs	Texture	tex
Scattered	scat	Thick	tk
Secondary	sec	Thin	tn
Sediment, sedimentary	sed	Throughout	thru
Sericite	seri	Tight, tightly	tt
Shaly	shy	Trace	tr
Silica, siliceous	sil	Unconsolidated	uncons
Silt	slt	Upper	up
Siltstone	sltst	Variable	var
Siltite	sltt	Varicolored	vcol
Silty	slty	Variegated	vgt
Size	sz	Varved	vrvd
Slabby	slab	Vein	vn
Slickensided	sks	Vertical	vert
Slight, slightly	sl	Very	v
Small	s	Vug, vuggy, vugular	vug
Smooth	sm	Water	wtr
Solution	sol	Wavy	wvy
Sort	srt	Weather, weathered	wthr, wthrd
Sorted	srtd	Well	w
Sorting	srtg	White	wh
Speck, speckled	spec	With	w/
Spot, spotted, spotty	sp	Yellow	yel
Stain, stained, staining	stn	Zone	zn

TABLE 2. — Symbols and abbreviations used for fractures in descriptions of drill cores

\ 75°	Single planar or nearly planar fracture, showing dip
\\ 80°	Parallel planar or nearly planar fractures, showing dip
⌊	Nearly planar, high-angle fracture which flattens downward in core
≀ 65°	Irregular fracture, showing approximate dip
⋇	Common curved anastomosing fractures
op	Open fracture
h	Healed fracture
op & h	Open and healed fractures in same interval

TABLE 3. — Intervals for graph of "Visual Porosity Estimate" on logs

Interval	Approximate Value
None	0 to less than 1 percent
Poor	1 to 3 percent
Good	3 to 10 percent
Excellent	Greater than 10 percent

TABLE 4. — Abbreviations for colors used in descriptions of drill core

Black	blk	Moderate	mod
Blue, bluish	bl	Pale	p
Brown, brownish	brn	Pink	pk
Color, colored	col	Red	r
Dark	dk	Purple	purp
Dusky	dsk	varicolored	vcol
Gray, grayish	gy	varigated	vgt
Green, greenish	gn	Very	v
Light, lighter	lt	White	wh
Medium	m	Yellow, yellowish	y
Orange	org		

Descriptions of colors made by comparison to colors in The Geological Society of America Rock Color Chart (1963).

TABLE 5. – Scale and symbols for grain size used in descriptions of drill core

Name of Size Class	Size Limits (metric)	Approximate English (common) Equivalents
Clay	<1/256 mm	<0.00015 in
Mud (mixed silt & clay)	<1/256 – 1/16 mm	<0.00015 – 0.002 in
Silt	1/256 – 1/16 mm	0.00015 – 0.002 in
Very fine sand	1/16 – 1/8 mm	0.002 – 0.005 in
Fine sand	1/8 – 1/4 mm	0.005 – 0.01 in
Medium sand	1/4 – 1/2 mm	0.01 – 0.02 in
Coarse sand	1/2 – 2 mm	0.02 – 0.08 in
Pebbles	2 – 64 mm	0.08 – 2.5 in

■• denotes range in grain size in interval on log, with dominant size at heavy bar and maximum size at heavy dot

TABLE 6. – Abbreviations and symbols for bedding and sedimentary structures used in descriptions of drill cores

THICKNESS OF BEDDING

Abbreviation	Thickness and splitting description	Scale cm	Scale in
vtk	very thickly bedded; massive	>100	>40
tk	thickly bedded; blocky	30 –100	12 – 40
av	average bedded; slabby	10 – 30	4 – 12
tn	thinly bedded; flaggy	3 – 10	1.2– 4
vtn	very thinly bedded	1 – 3	0.4– 1.2
l	laminated; platy, shaly	0.3 – 1	0.12– 0.4
tnl	thinly laminated; papery, fissile	0.3	0.12
h	homogeneous; massive		

TABLE 6. — Abbreviations and symbols for bedding and sedimentary structures used on descriptions of drill cores — Continued

CROSSBEDDING

Abbreviation	Scale	Thickness of bed sets
s	small scale	5 cm
m	medium scale	5 cm – 2 m
l	large scale	2 m – 8 m
vl	very large scale	8 m
t	tabular	
wp	wedge planar	

Abbreviation	Symbol	Type of bedding
ad		antidune
tr		trough (festoon)
cu		convex upward
hb		herringbone

GRADED BEDDING

Abbreviation	Symbol	Type of grading
ngrd		normal (becoming finer upward)
rgrd		reverse (coarsening upward)
cgrd		cyclic (within a bed)

LAMINATIONS

Abbreviation	Symbol	Type of lamination
mxlam		microcross-lamination
e ‖		even parallel
w ‖		wavy parallel
de ‖		discontinuous even parallel
dw ‖		discontinuous wavy parallel
c ‖		curved parallel
dc ‖		discontinuous curved parallel
en ‖		even nonparallel
den ‖		discontinuous even nonparallel
wn ‖		wavy nonparallel
dwn ‖		discontinuous wavy parallel
conv		convolute

TABLE 6. – Abbreviations and symbols for bedding and sedimentary structures used on descriptions of drill cores – Continued

RIPPLES

Abbreviation	Symbol	Type of ripple
gen		general
asym		asymmetric
sym		symmetric
clbg		climbing
fsr		flaser
tncd		truncated

BEDDING PLANE MARKINGS

Abbreviation	Symbol	Type of marking
sol		sole marking
srfm		surface markings
cst		cast
mc		dessication and syneresis cracks
rp		rain print
stri		striae
slt		salt casts

DEFORMED BEDDING

Symbol	Type of Deformed Bedding
	small scale fault
	fracture
	slickenside
	slump
	load cast
	flute cast
	flame or wisp
	dish
	contorted
	ball and pillow
	dikes and wedges

arg argillite fill
sltt siltite fill

TABLE 6. — Abbreviations and symbols for bedding and sedimentary structures used on descriptions of drill cores — Continued

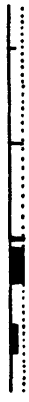
DEFORMED BEDDING — Continued

Symbol	Type of deformed bedding
	pull apart
	brecciation
	mud-chip breccias or lenses
	fluid escape structure
	horizontal roll structure
	truncated mud lump in clay laminae

MISCELLANEOUS STRUCTURES

Symbol	Type of structure
	clasts
	argillite
	siltite
	balls
	armored clay
	small scale scour and fill
	vertical wall of scour, with fill
	lenses of very fine sand in mud, concave upward

TABLE 7. — Symbols for distribution of "ore" minerals and alteration minerals



disseminated grains or discontinuous pods or lenses

disseminated uniformly or continuously in laminae or beds

pervasive in laminae or through interval of core

concentrated along fracture

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-2

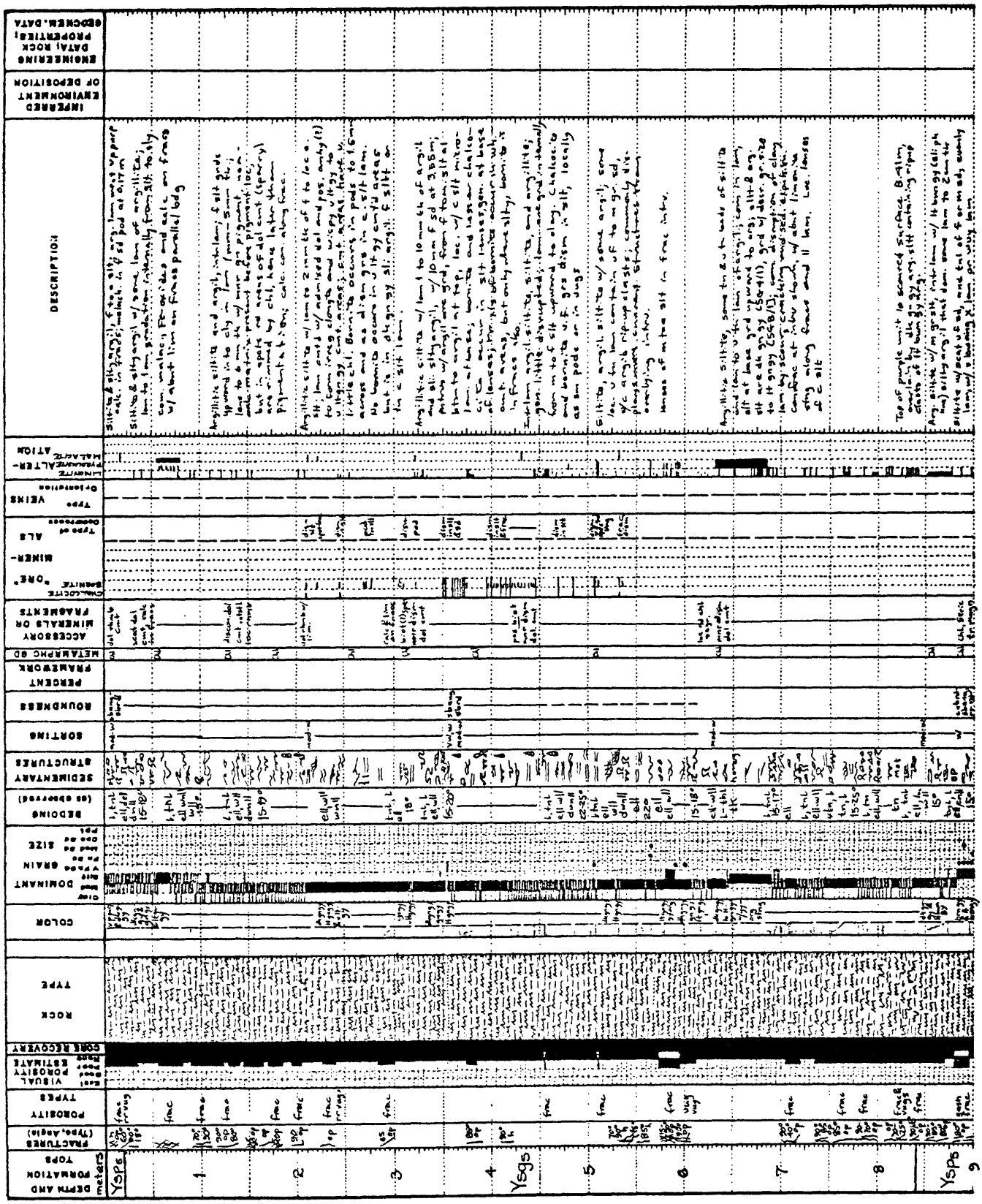


FIGURE 3. — Description of drill core from Blacktail Mountain, Montana, core hole BT-2

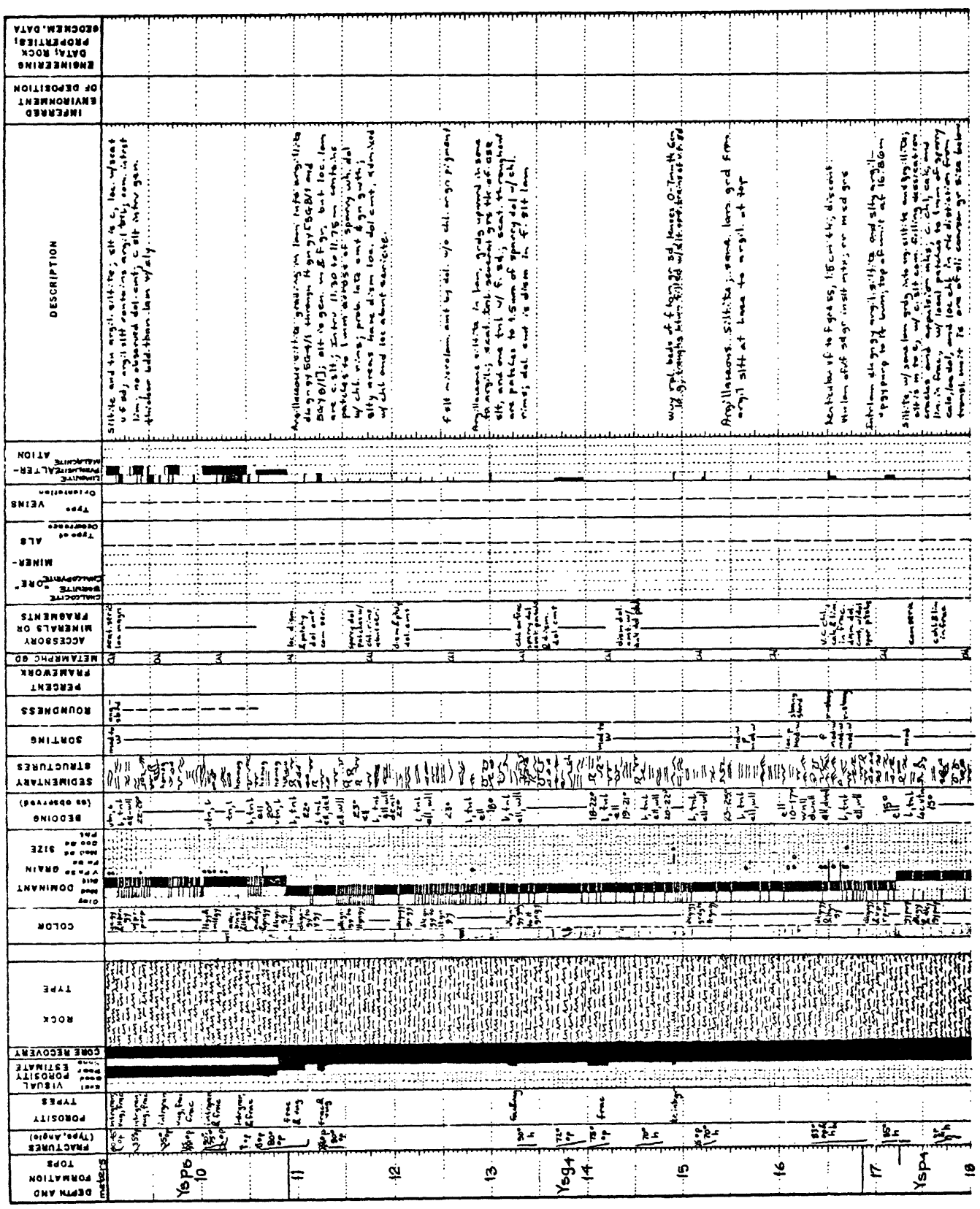


FIGURE 3. — Description of drill core from Blacktail Mountain, Montana, core hole BT-2 — Continued

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-2

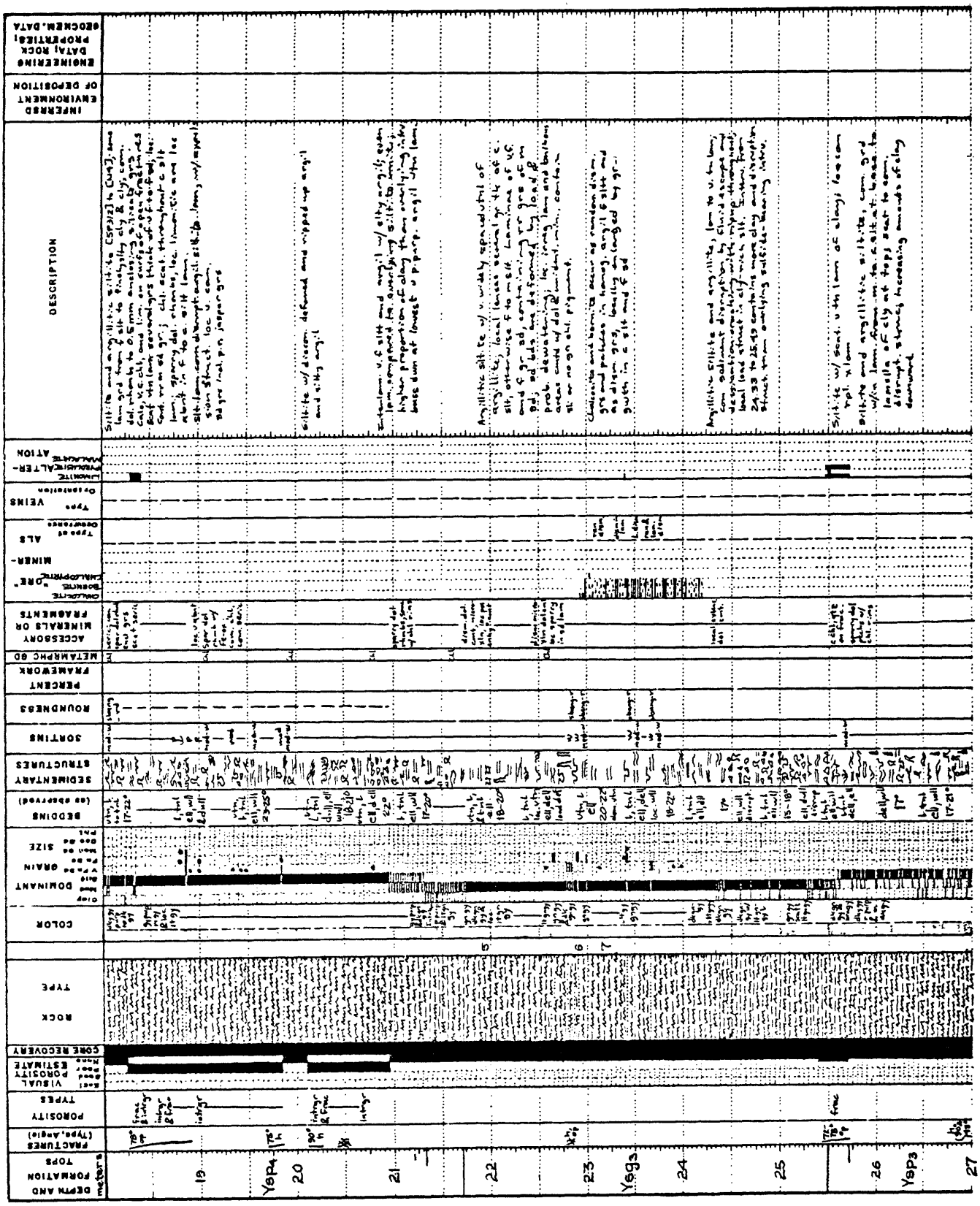


FIGURE 3. — Description of drill core from Blacktail Mountain, Montana, core hole BT-2 — Continued.

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-2

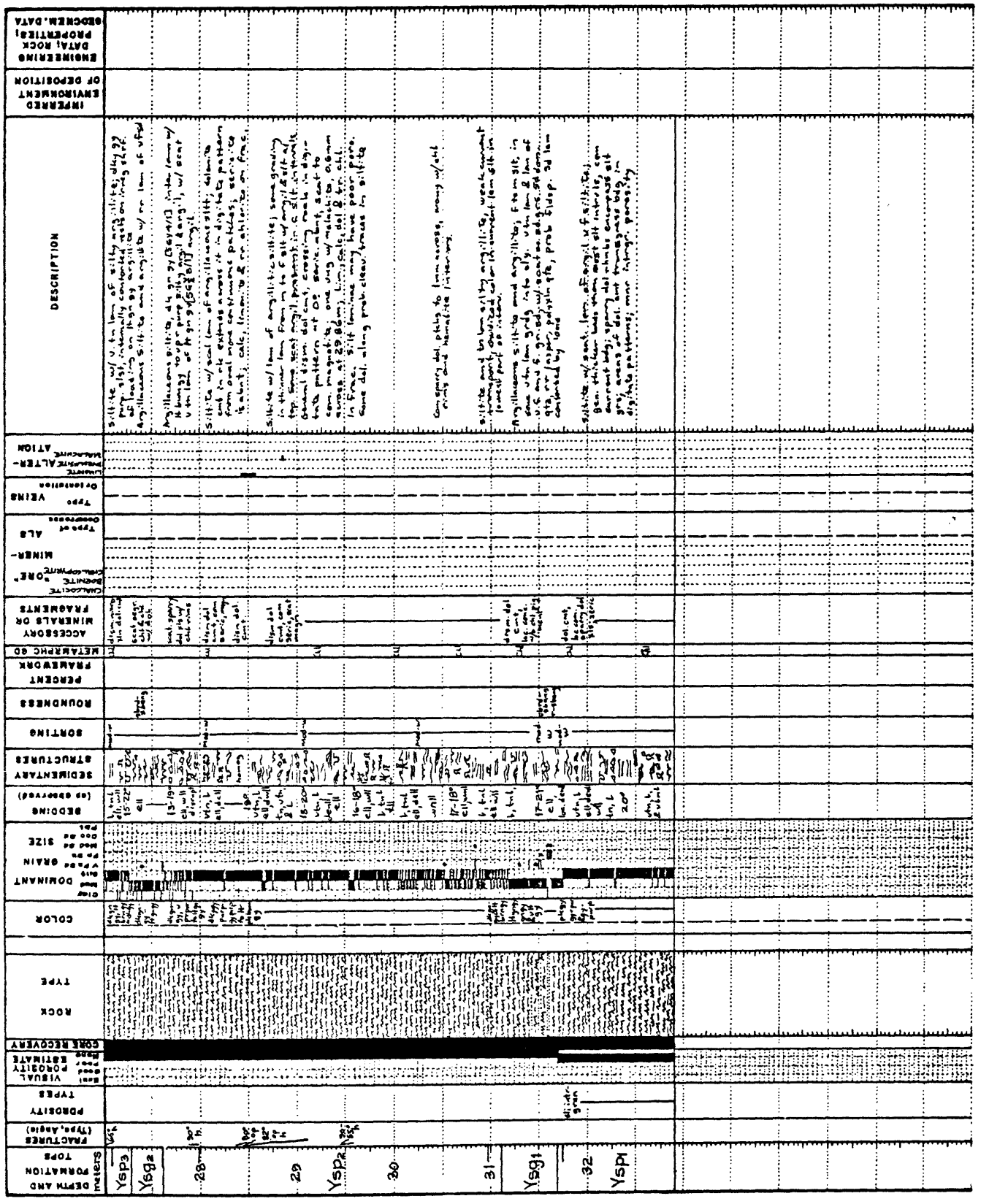


FIGURE 3. — Description of drill core from Blacktail Mountain, Montana, core hole BT-2 — Concluded

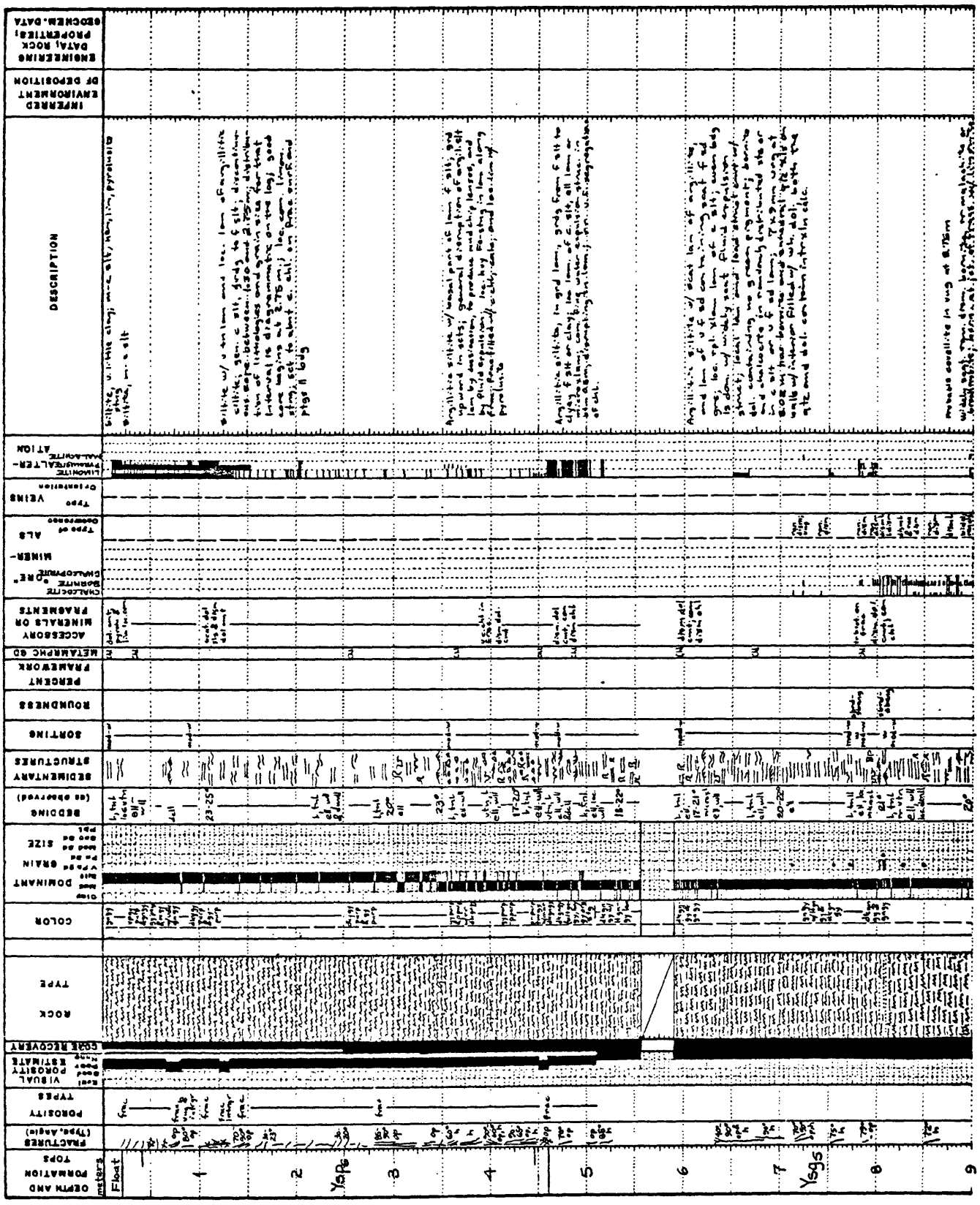


FIGURE 4. — Description of drill core from Blacktail Mountain, Montana, core hole BT-3

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-3

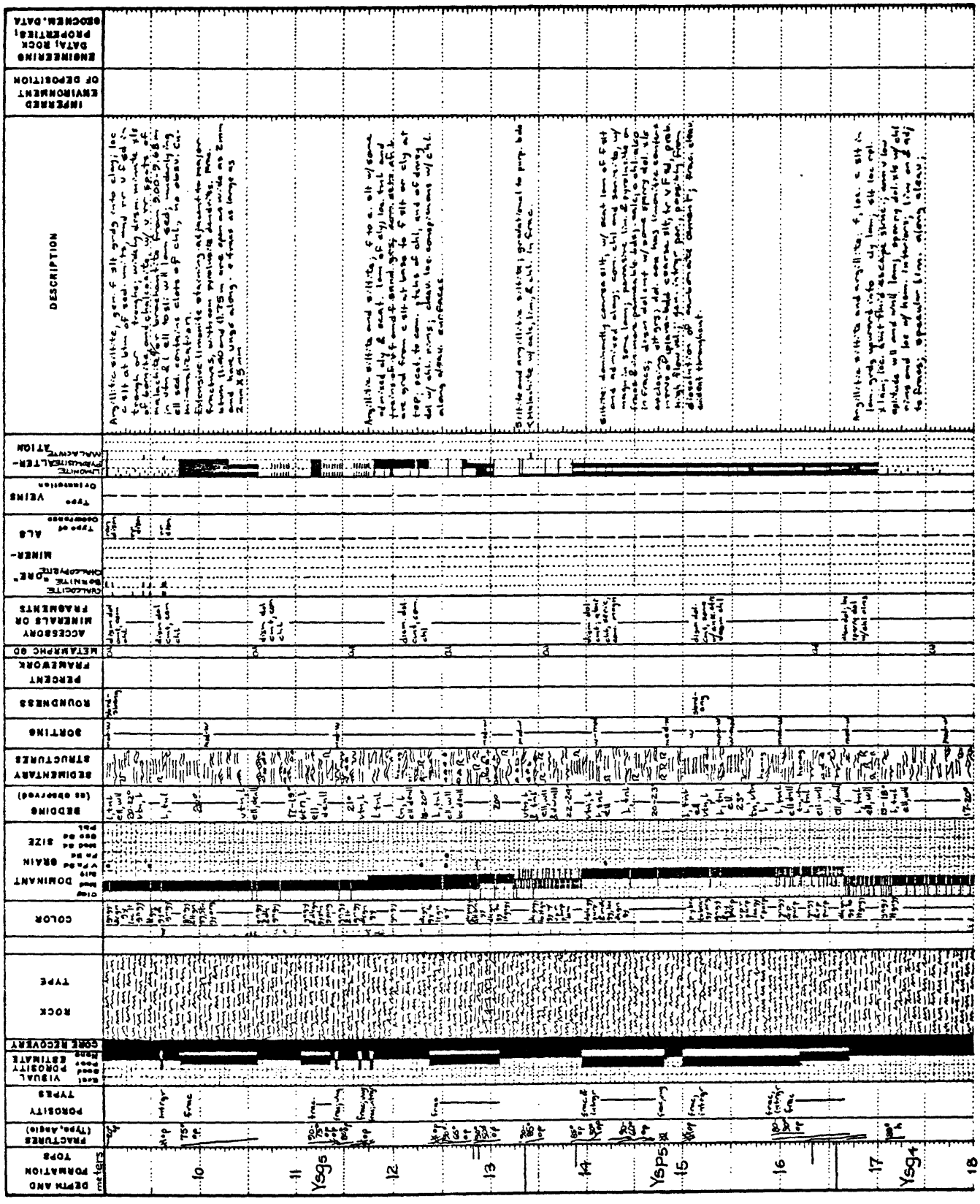


FIGURE 4. — Description of drill core from Blacktail Mountain, Montana, core hole BT-3 — Continued

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-3

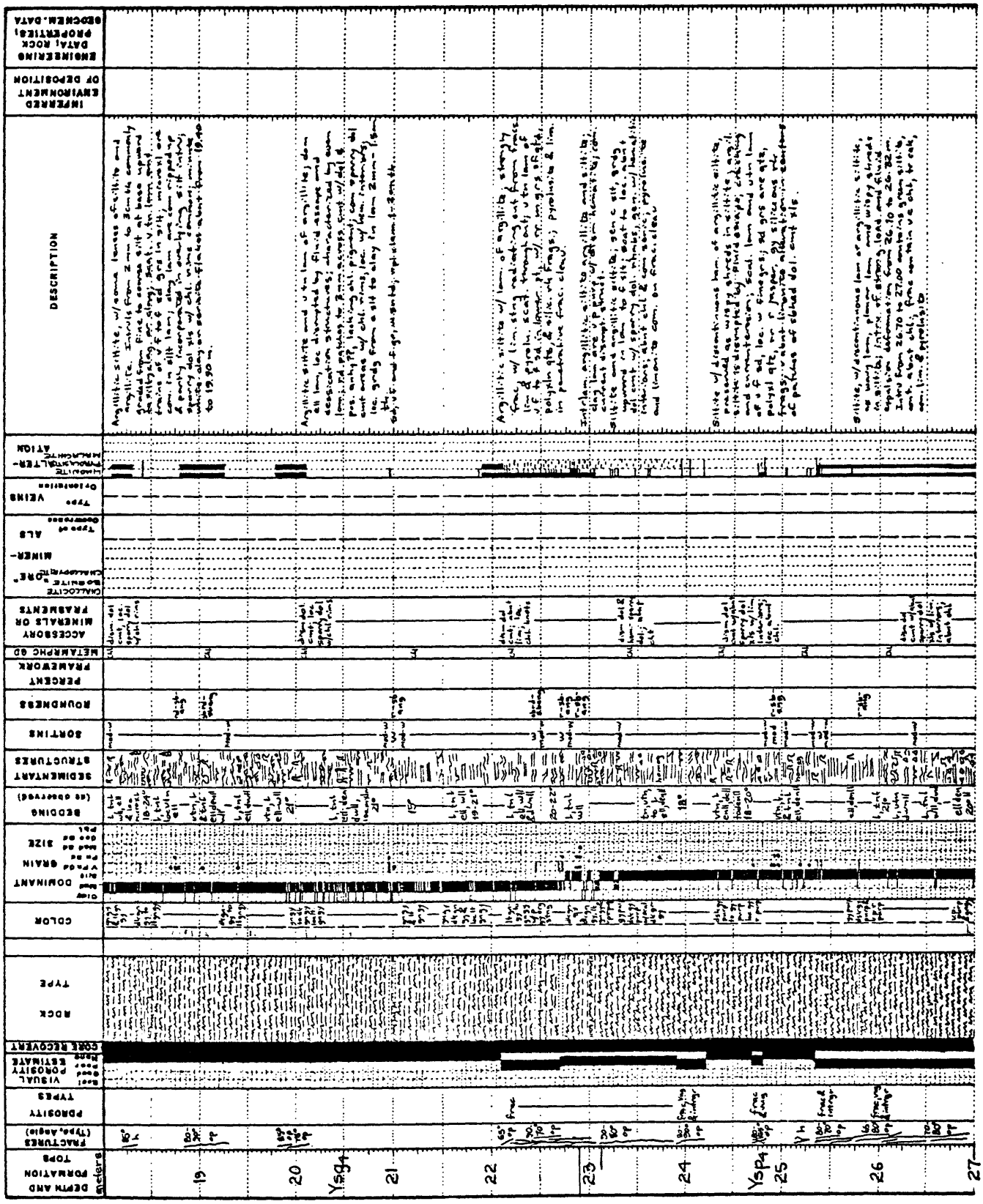


FIGURE 4. — Description of drill core from Blacktail Mountain, Montana, core hole BT-3 — Continued

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-3

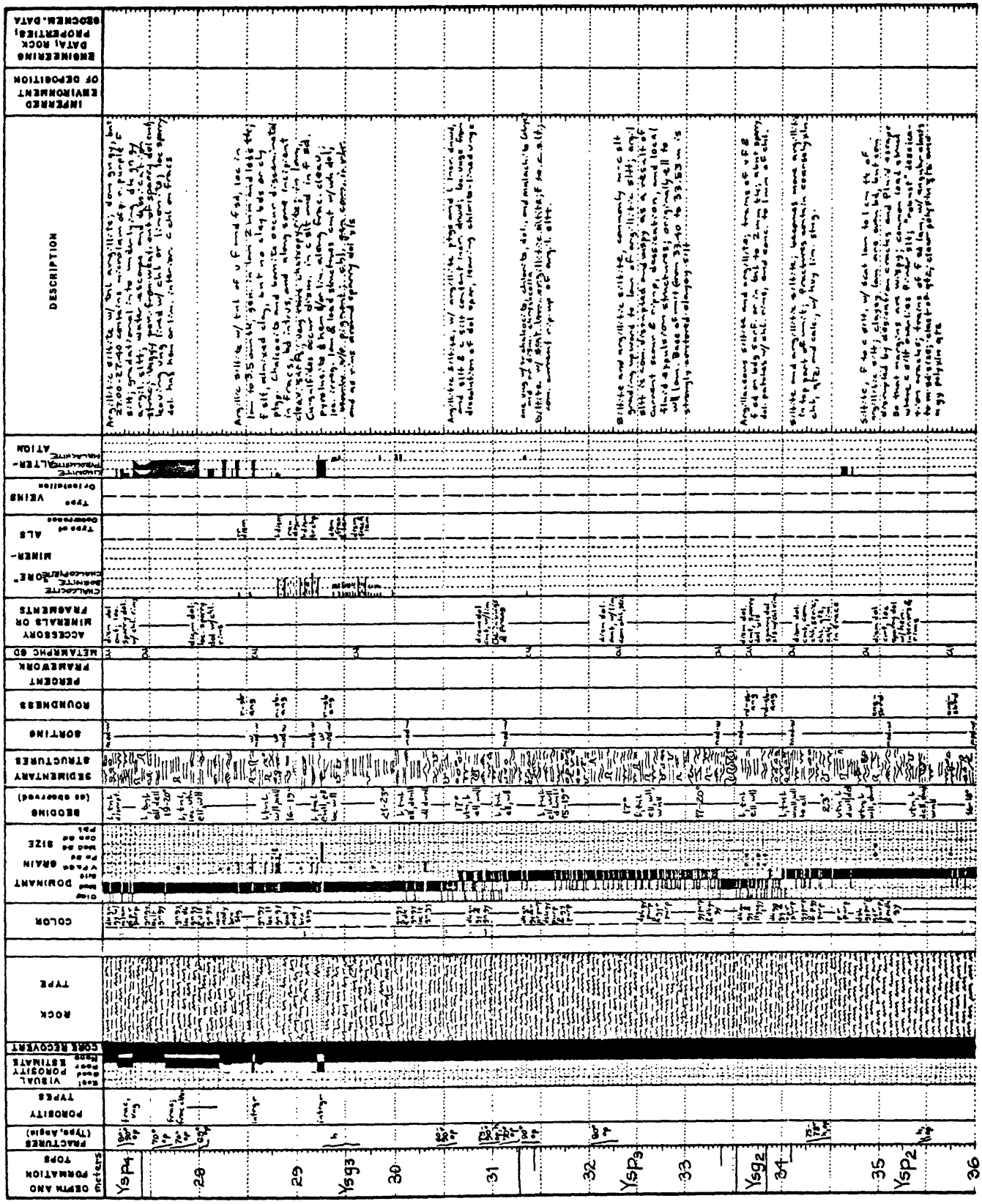


FIGURE 4. — Description of drill core from Blacktail Mountain, Montana, core hole BT-3 — Continued

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-3

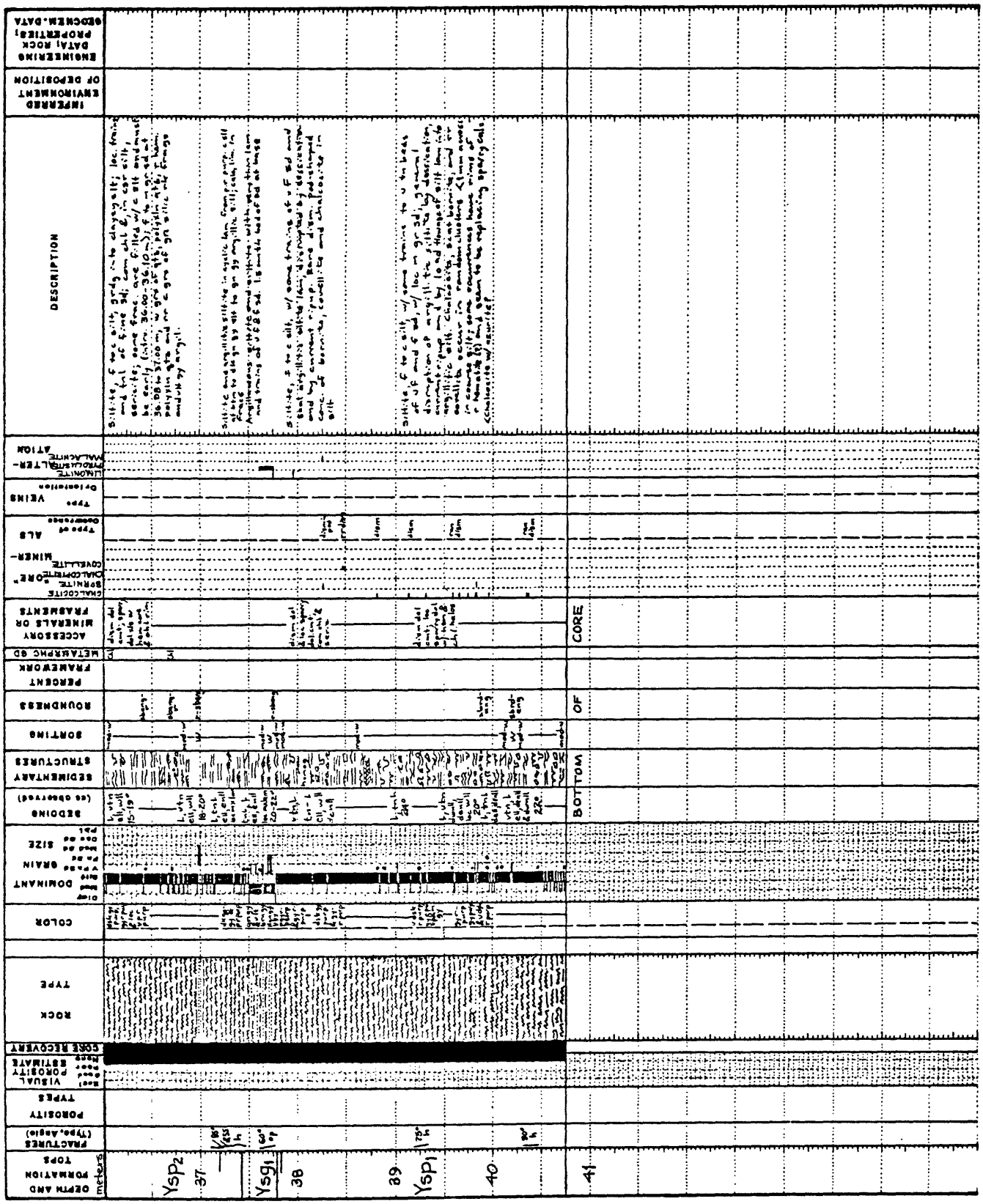


FIGURE 4. — Description of drill core from Blacktail Mountain, Montana, core hole BT-3 — Concluded

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-12

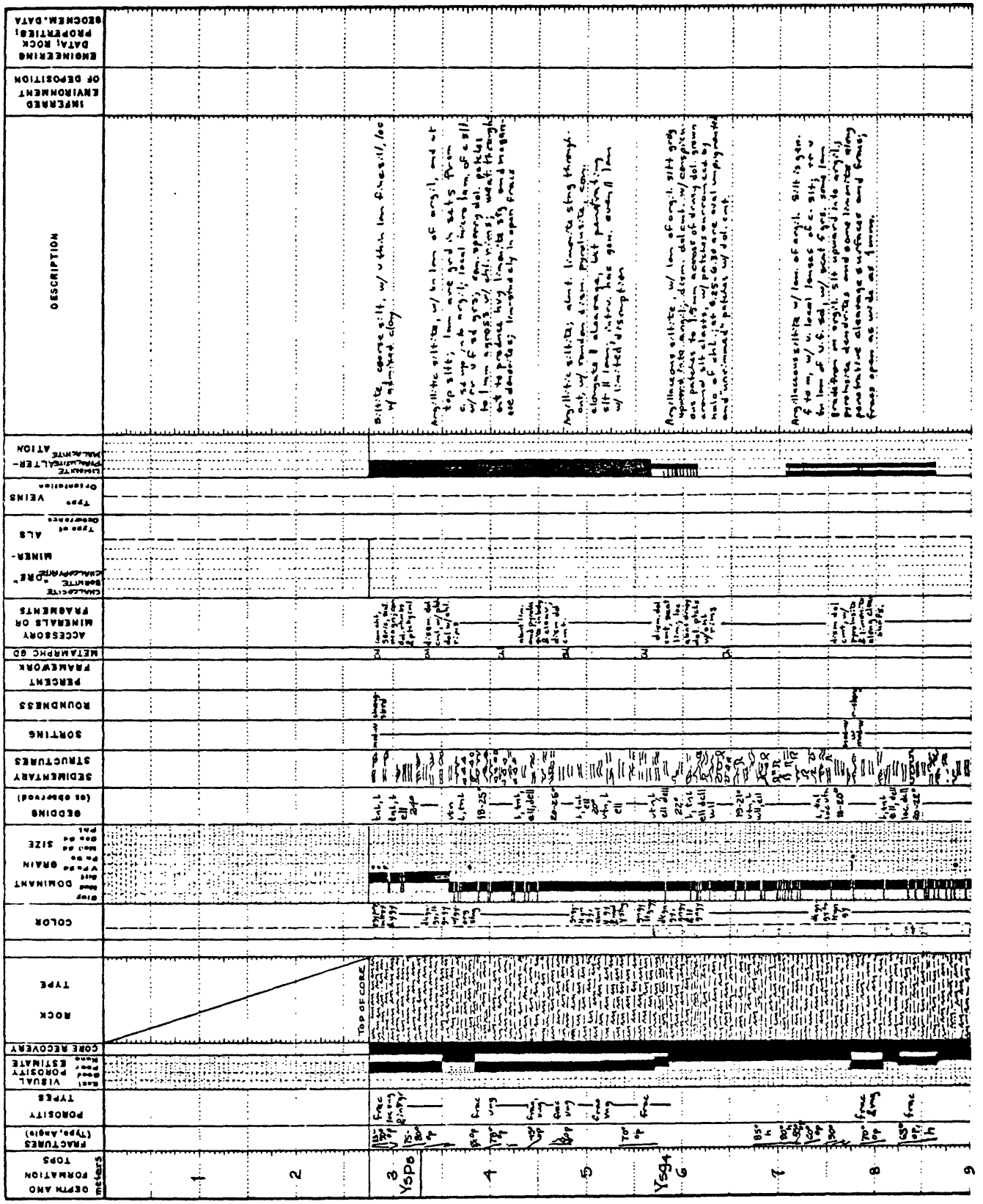


FIGURE 5. — Description of drill core from Blacktail Mountain, Montana, core hole BT-12

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-12

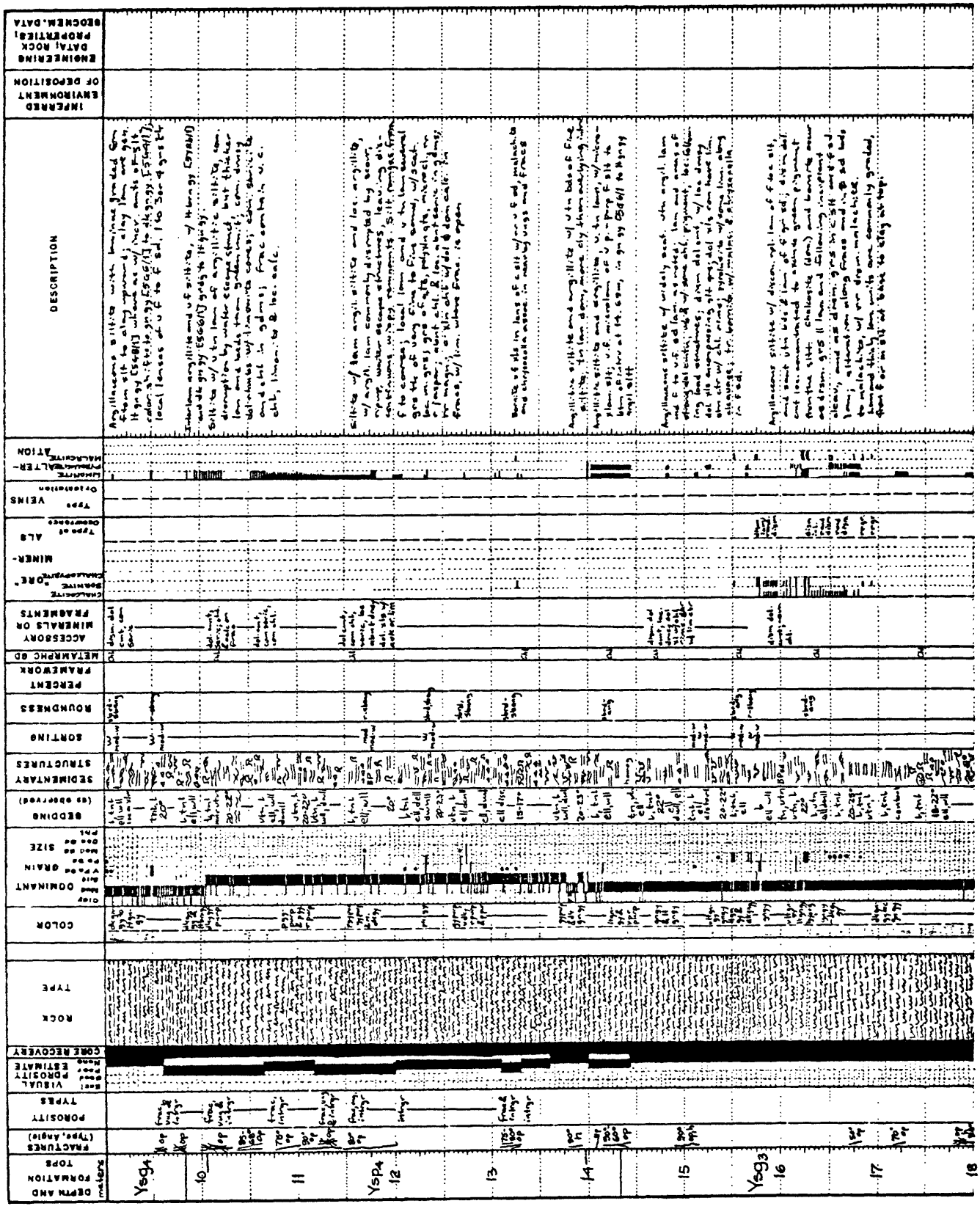


FIGURE 5. — Description of drill core from Blacktail Mountain, Montana, core hole BT-12 – Continued

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-12

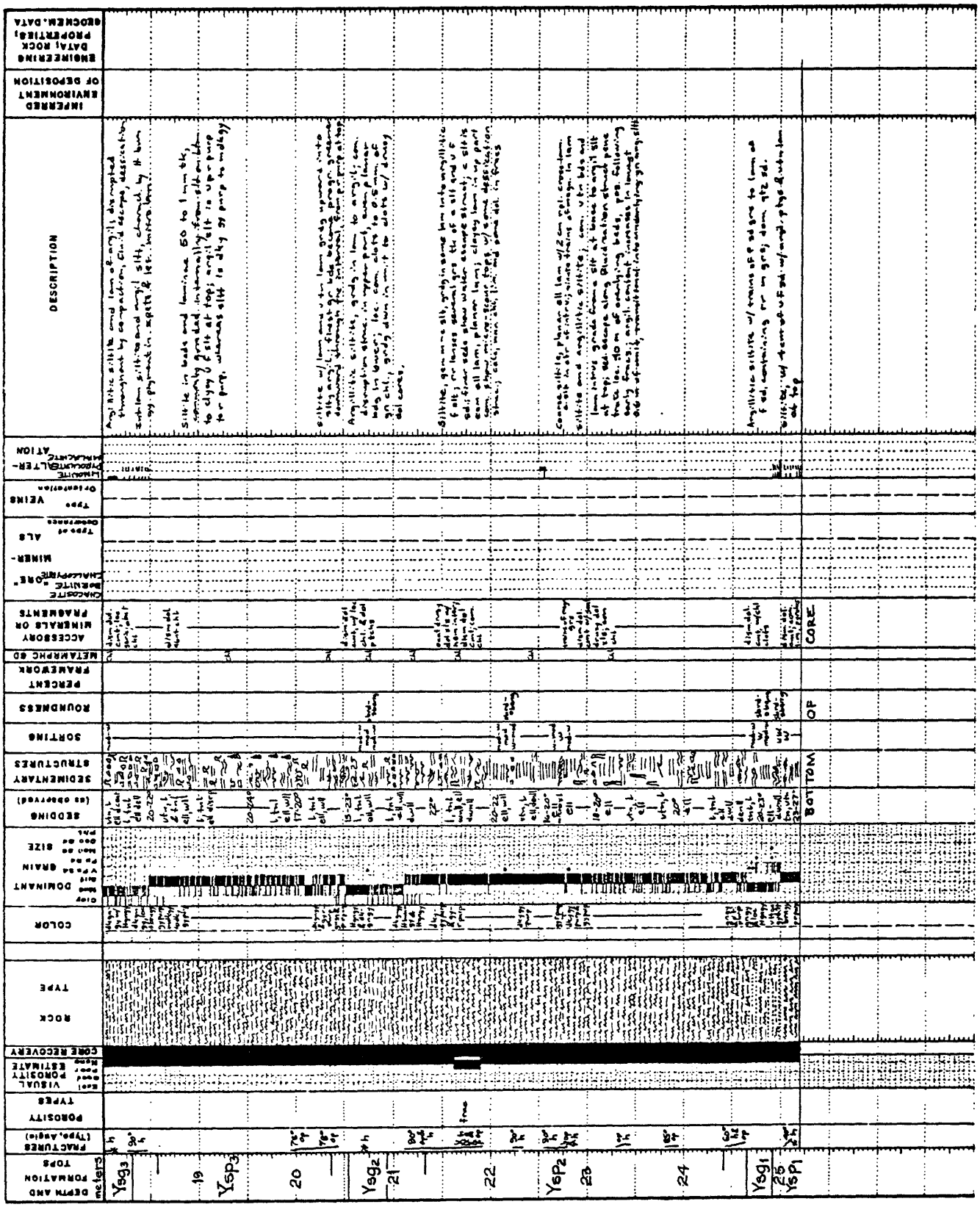


FIGURE 5. — Description of drill core from Blacktail Mountain, Montana, core hole BT-12 — Concluded

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-15

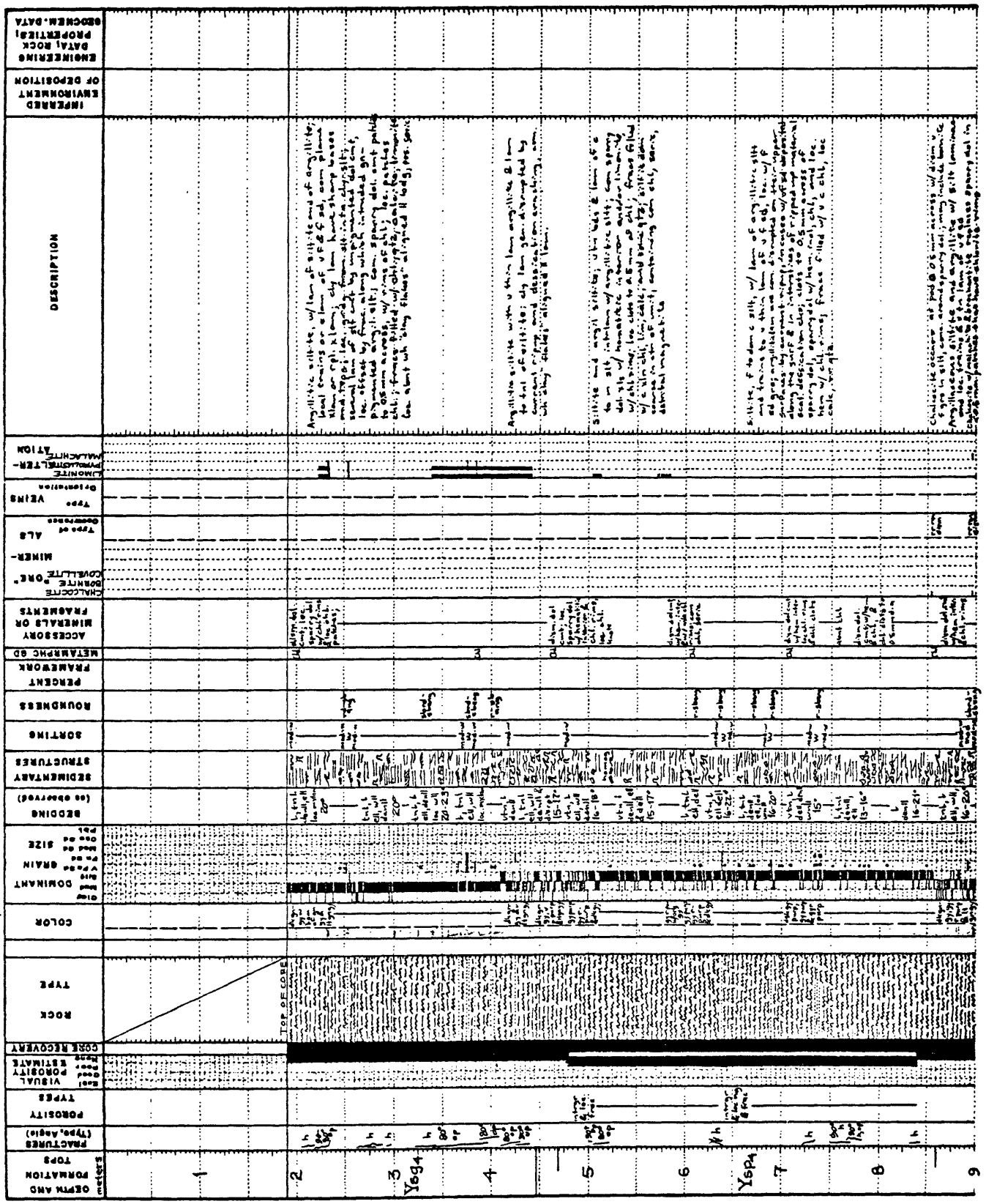


FIGURE 6. — Description of drill core from Blacktail Mountain, Montana, core hole BT-15

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-15

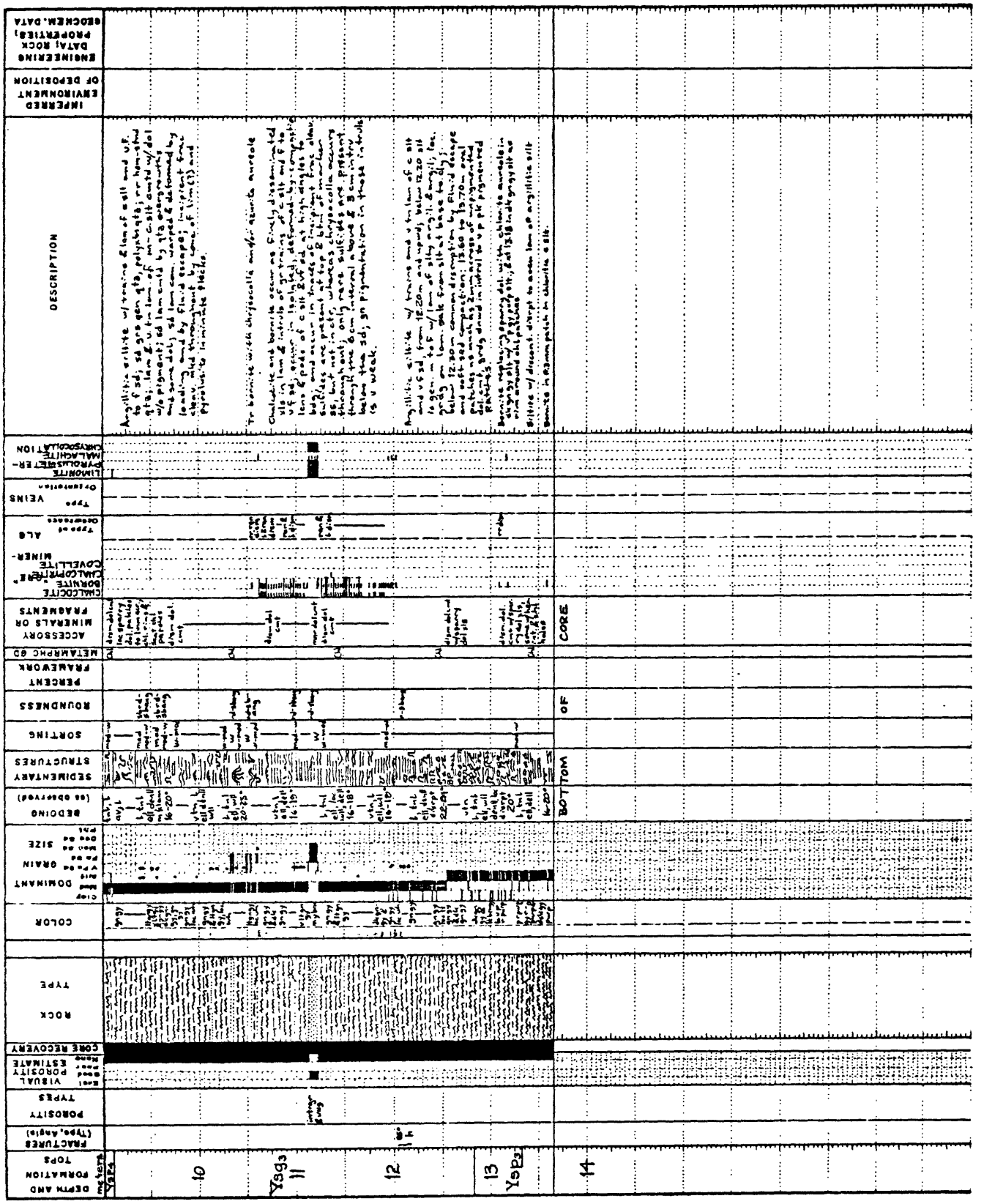


FIGURE 6. — Description of drill core from Blacktail Mountain, Montana, core hole BT-15 — Concluded

BLACKTAIL MOUNTAIN MONTANA CORE HOLE BT-16

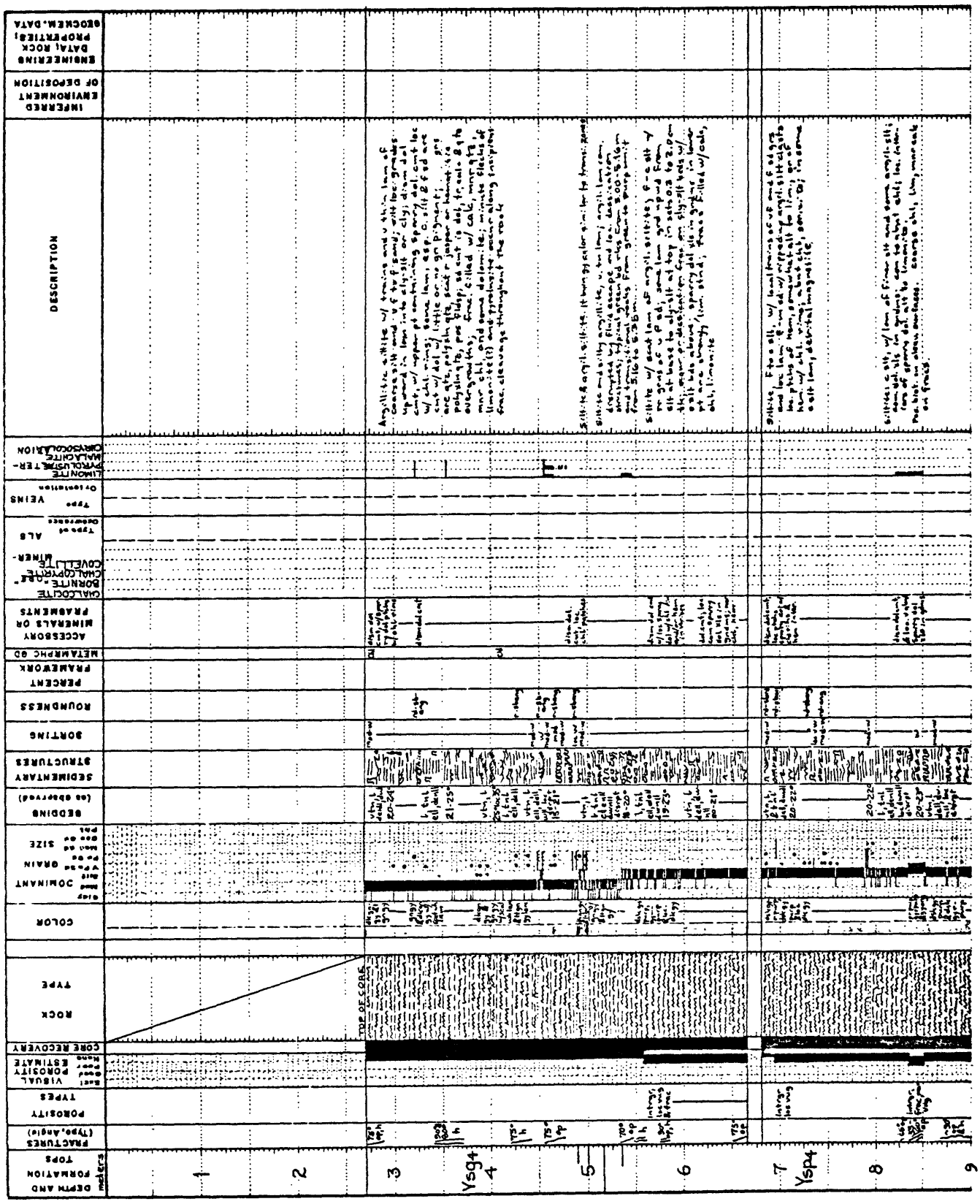


FIGURE 7. — Description of drill core from Blacktail Mountain, Montana, core hole BT-16

BLACKTAIL MOUNTAIN MONTANA CORE HOLE BT-16

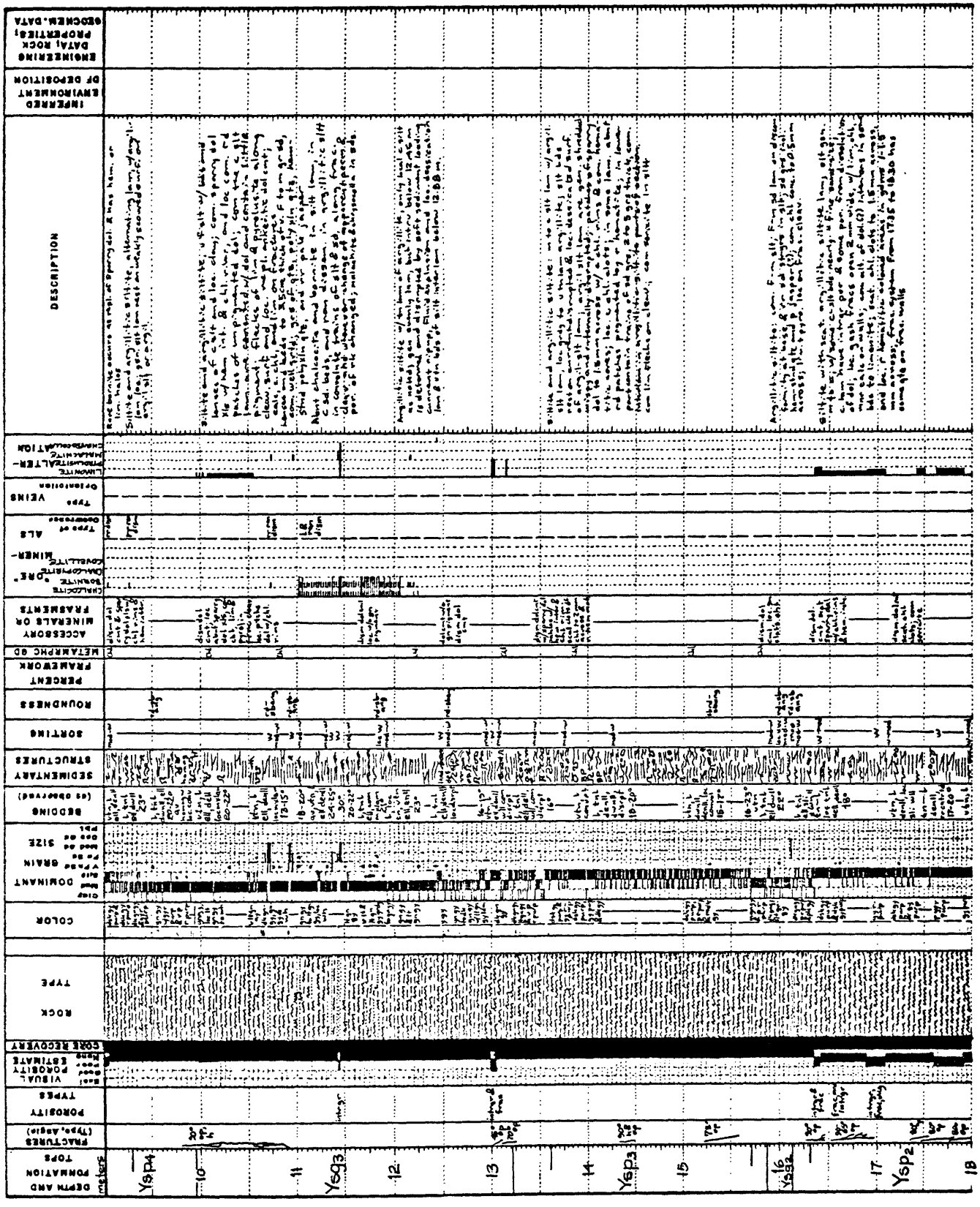


FIGURE 7. — Description of drill core from Blacktail Mountain, Montana, core hole BT-16 — Continued

BLACKTAIL MOUNTAIN MONTANA CORE HOLE BT-16

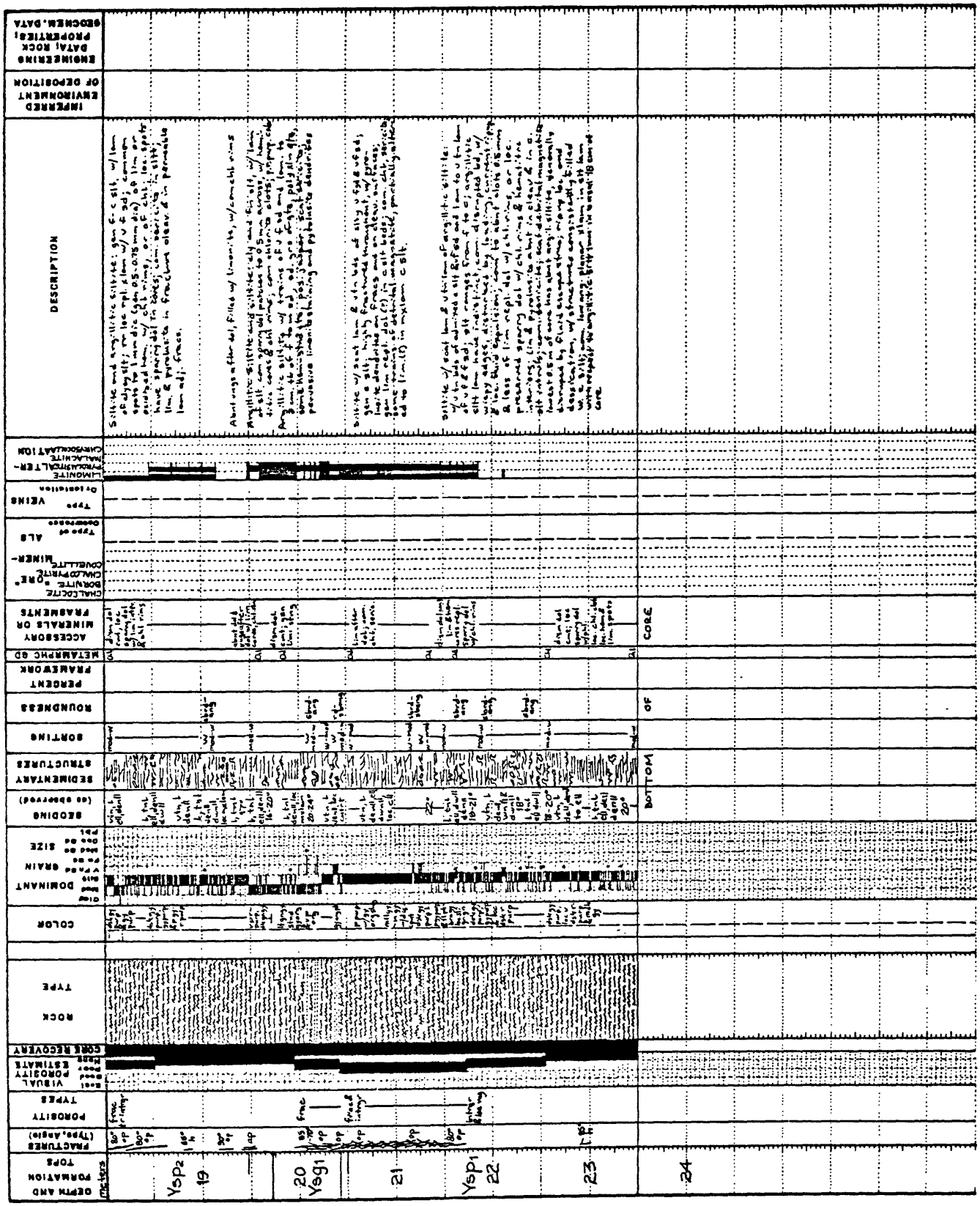


FIGURE 7. — Description of drill core from Blacktail Mountain, Montana, core hole BT-16 — Concluded

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-17

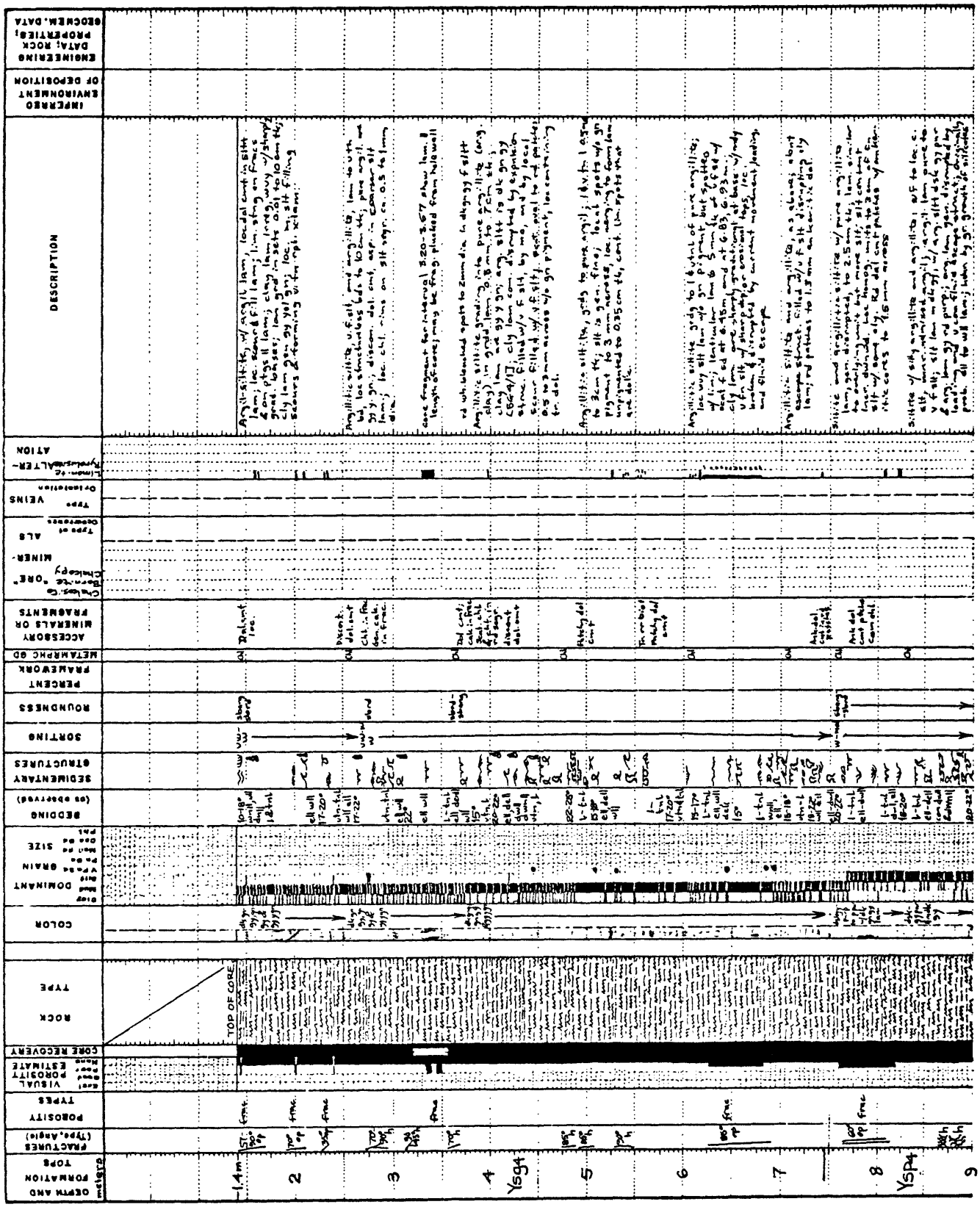


FIGURE 8. — Description of drill core from Blacktail Mountain, Montana, core hole BT-17

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-17

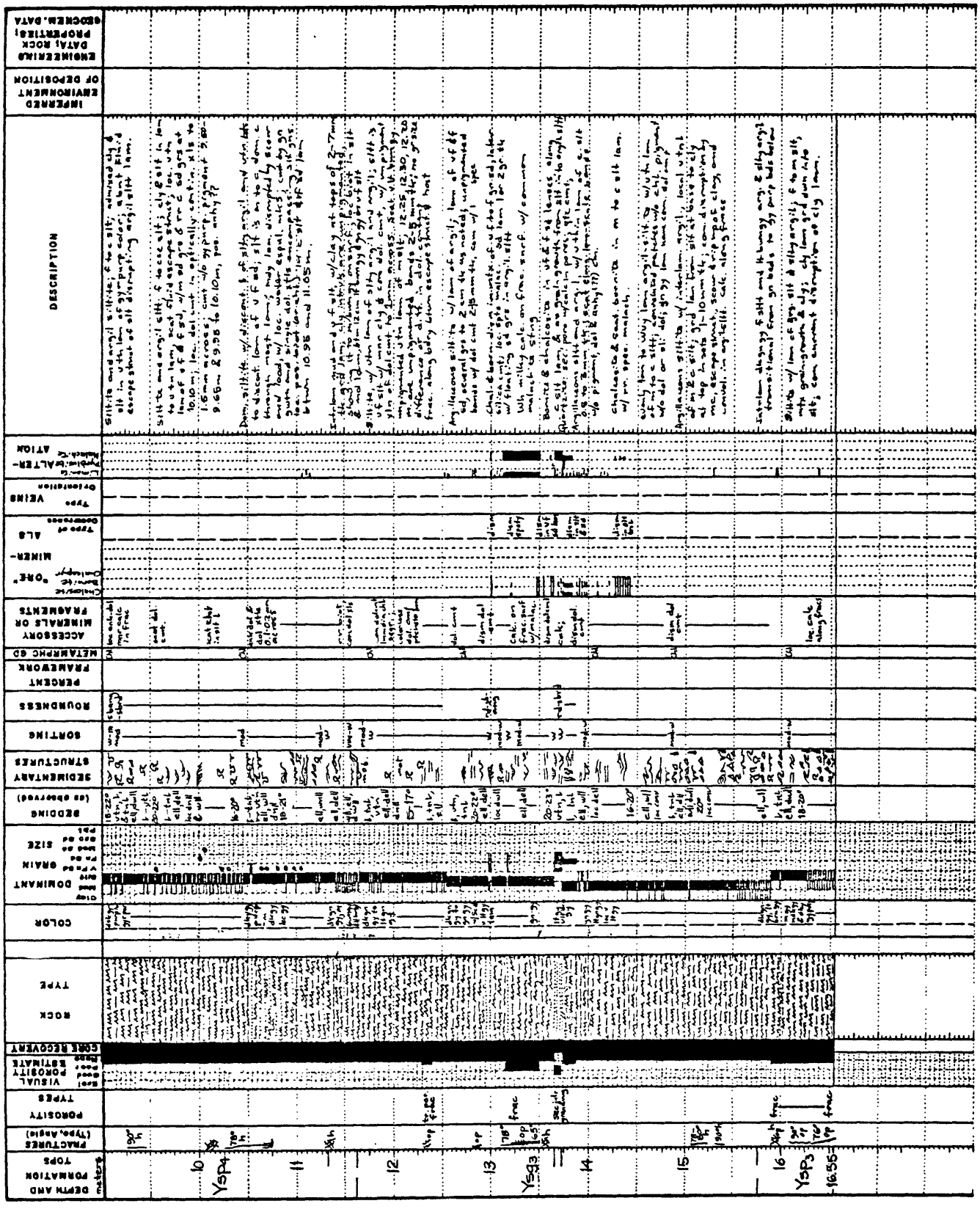


FIGURE 8. — Description of drill core from Blacktail Mountain, Montana, core hole BT-17 — Concluded

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-19

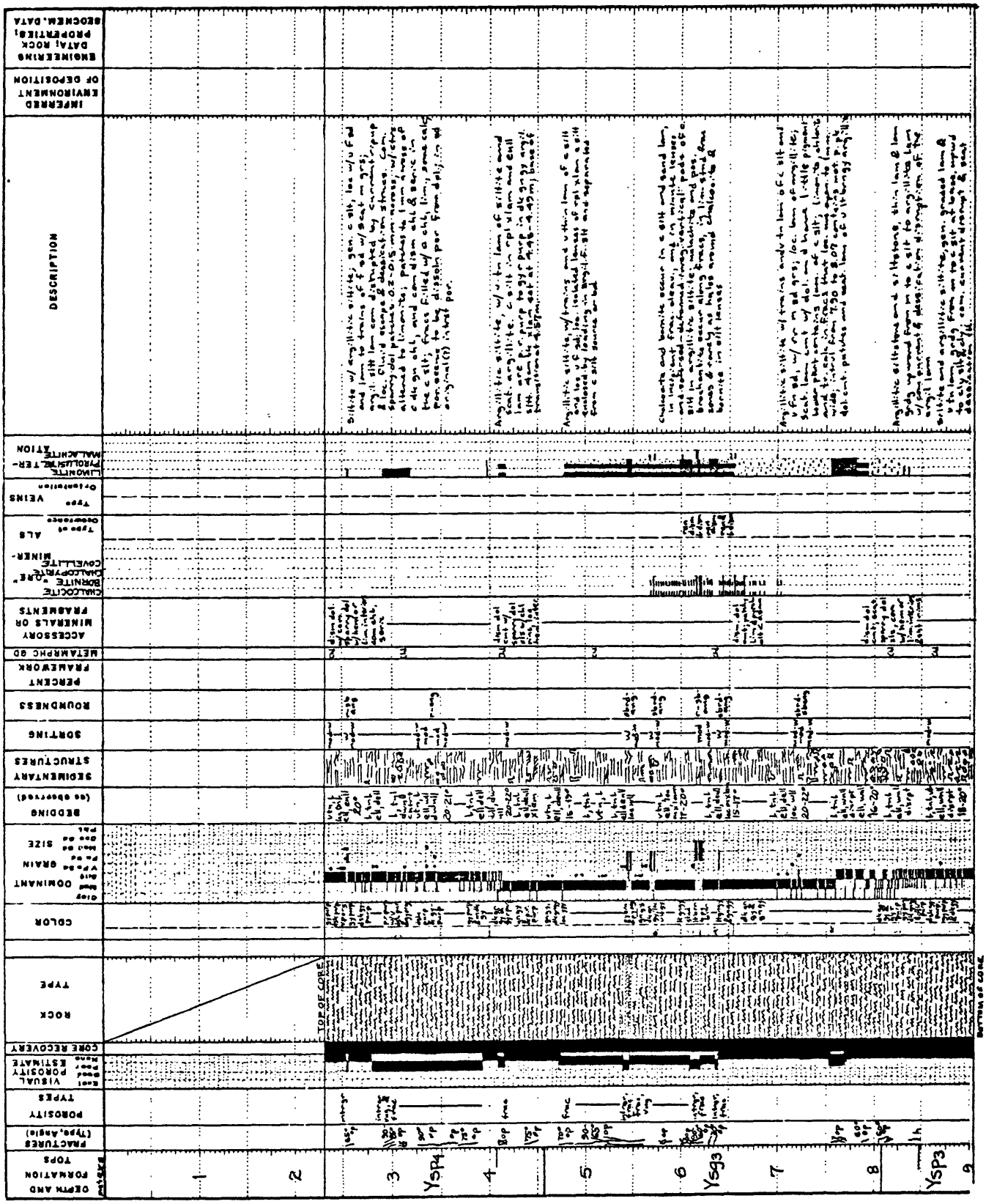


FIGURE 9. — Description of drill core from Blacktail Mountain, Montana, core hole BT-19

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-20

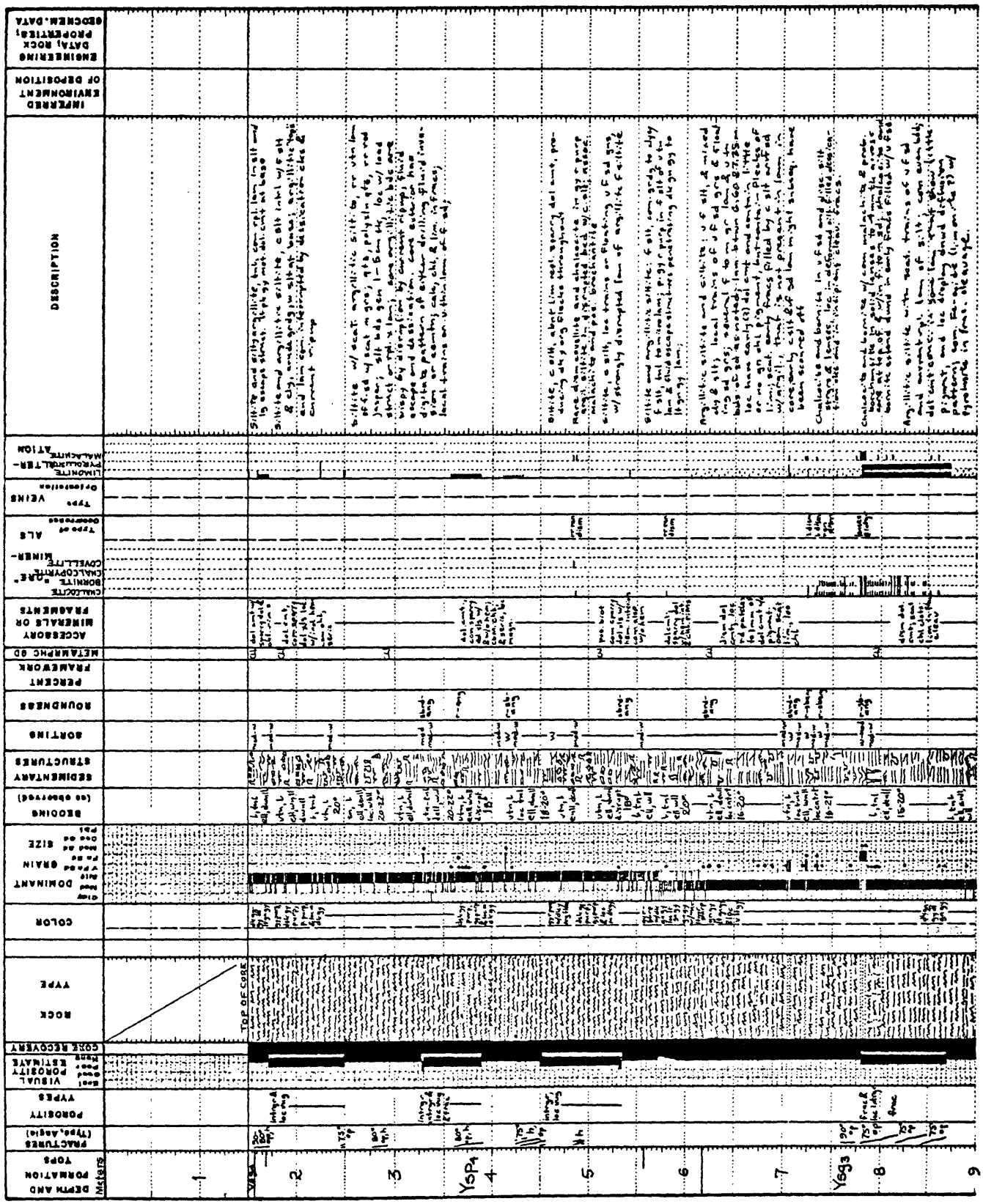


FIGURE 10. — Description of drill core from Blacktail Mountain, Montana, core hole BT-20

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-20

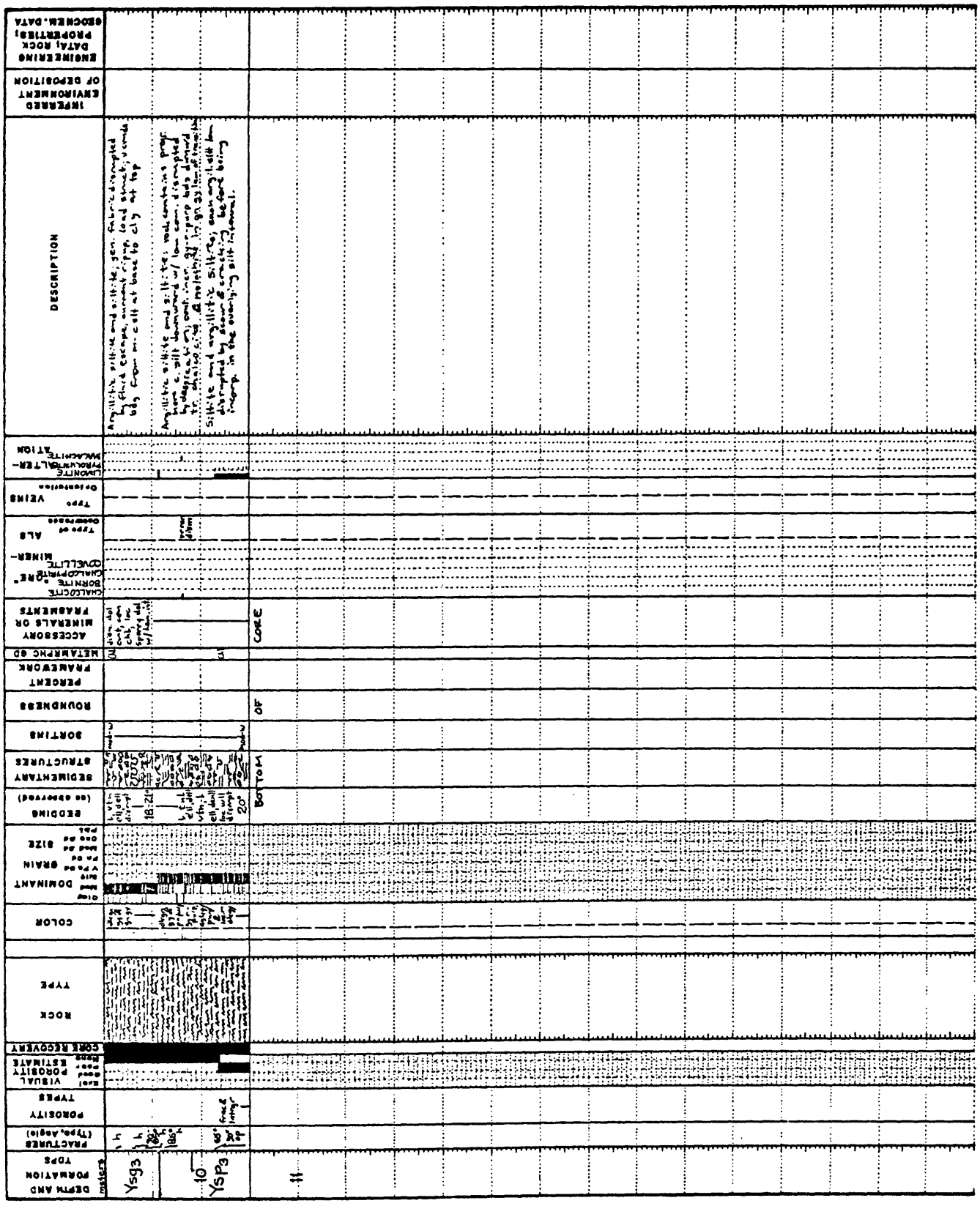


FIGURE 10 — Description of drill core from Blacktail Mountain, Montana, core hole BT-20 — Concluded

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-21

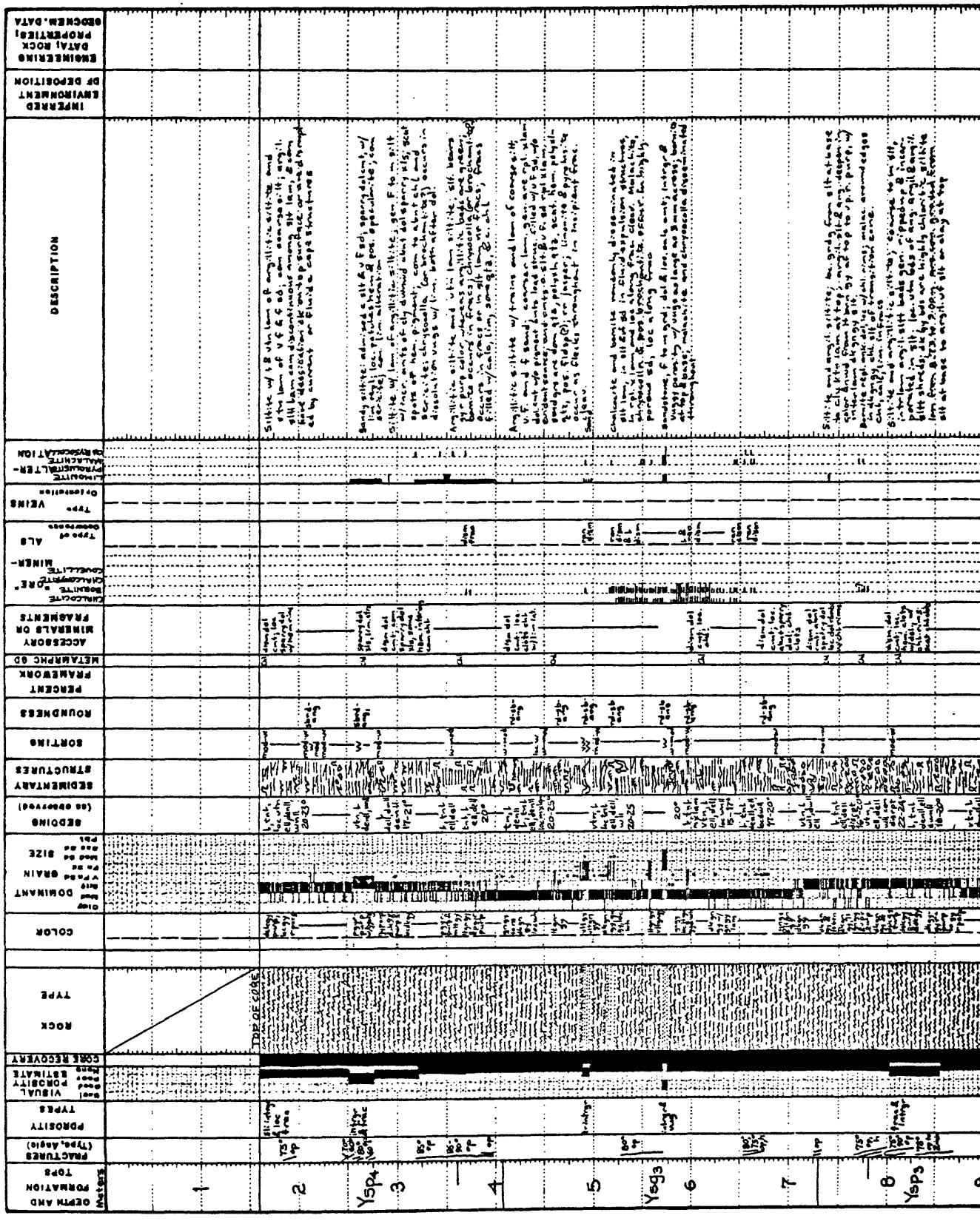


FIGURE 11. - Description of drill core from Blacktail Mountain, Montana, core hole BT-21

BLACKTAIL MOUNTAIN, MONTANA CORE HOLE BT-21

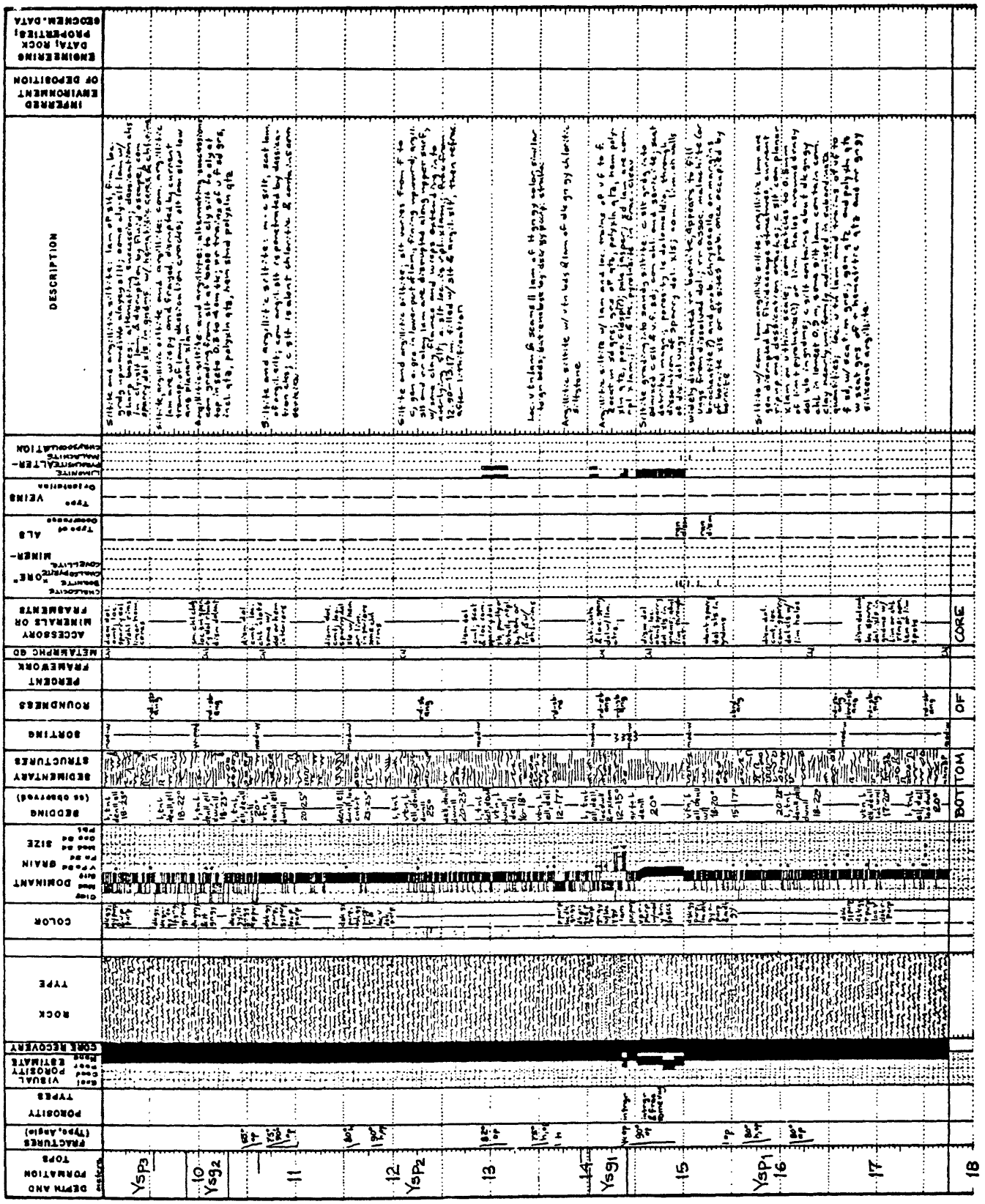


FIGURE 11. — Description of drill core from Blacktail Mountain, Montana, core hole BT-21 — Concluded

BLACKTAIL MOUNTAIN MONTANA CORE HOLE BT-22

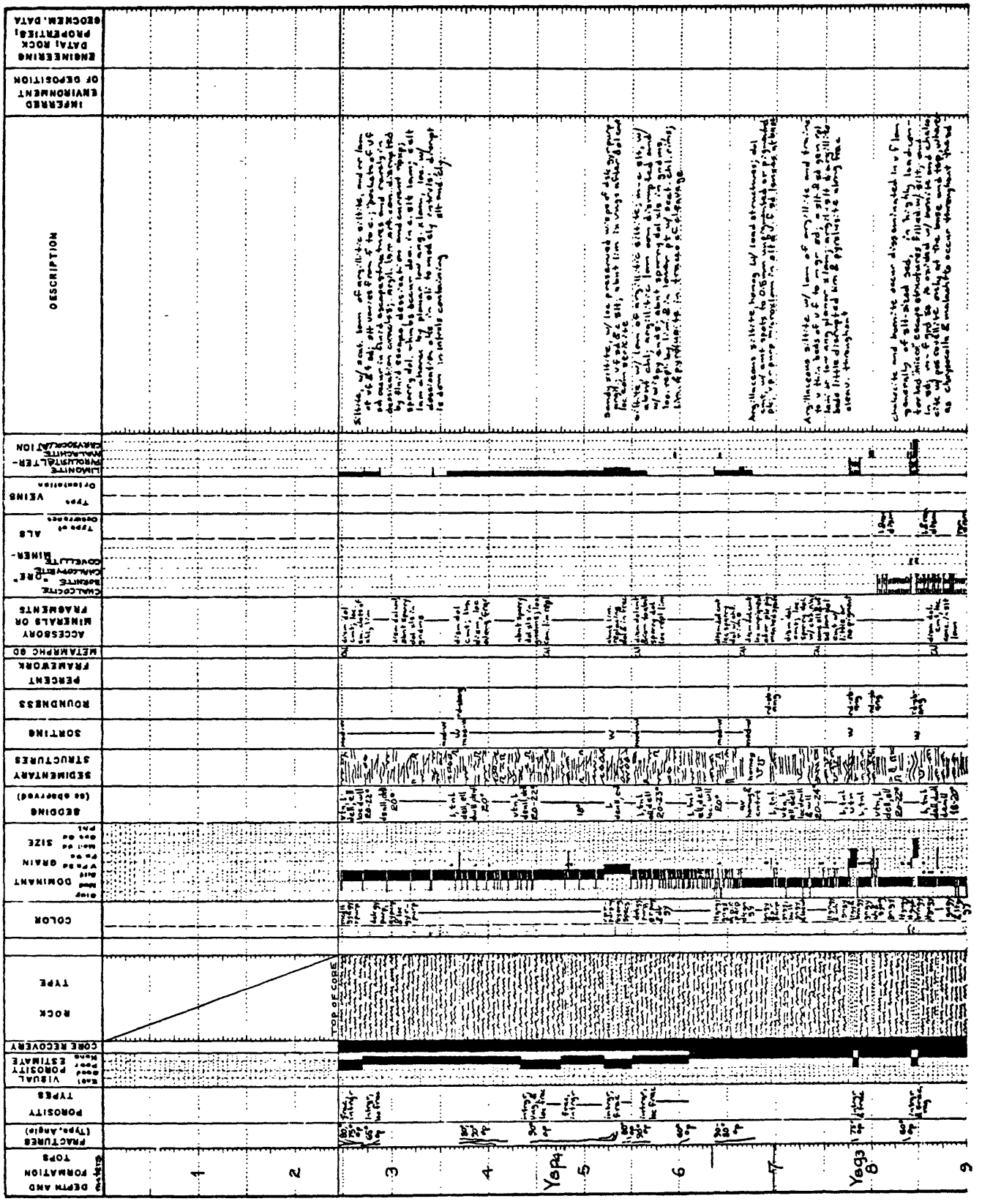


FIGURE 12. - Description of drill core from Blacktail Mountain, Montana, core hole BT-22 - Continued

BLACKTAIL MOUNTAIN MONTANA CORE HOLE BT-22

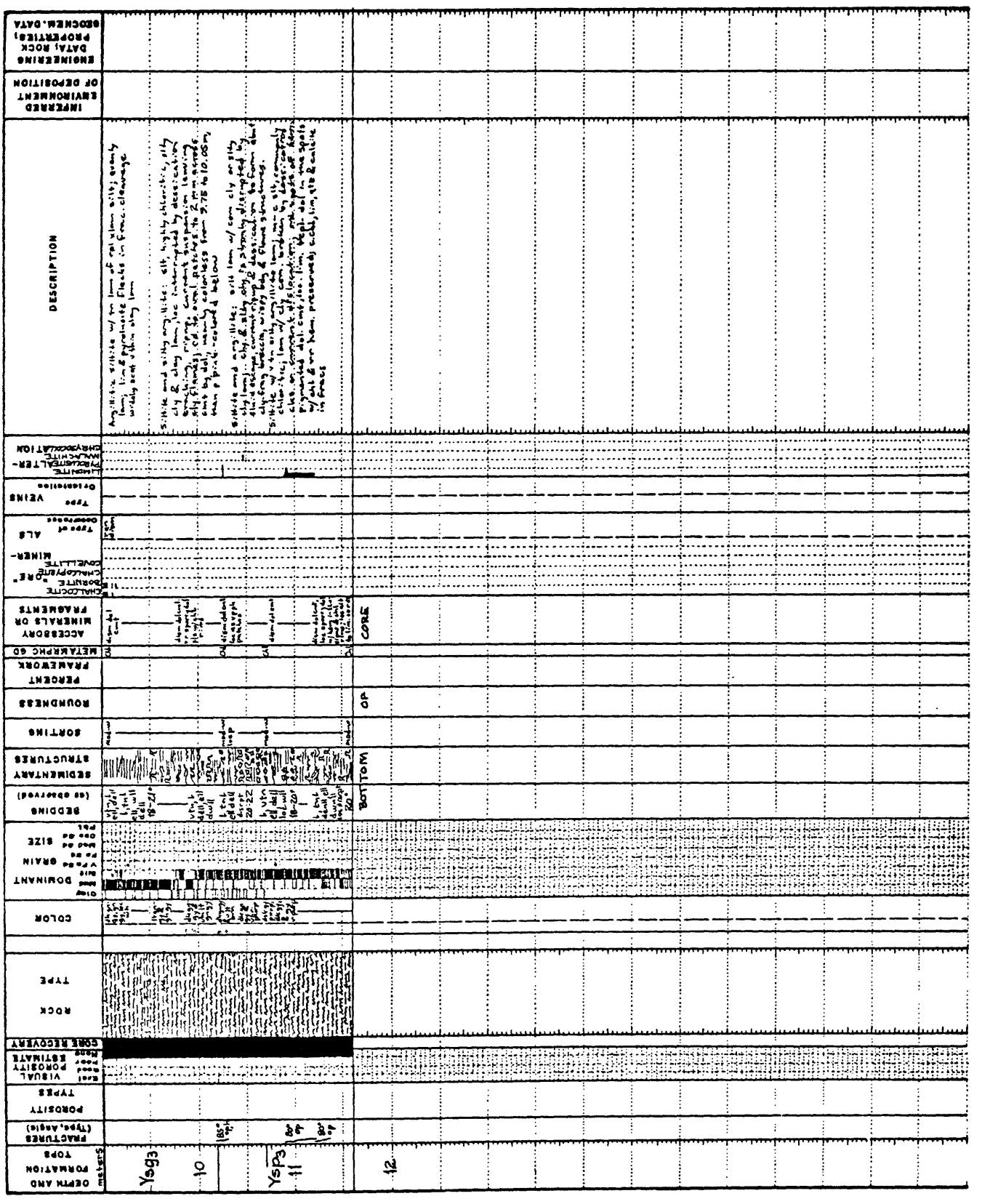


FIGURE 12. — Description of drill core from Blacktail Mountain, Montana, core hole BT-22 — Concluded