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DRILLING, MEASURED SECTION, AND GEOCHEMICAL DATA ON WEATHERED PROFILES IN SOUTHWEST QUEENSLAND

by

B.R. Senior

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ERRATA

Contents	2nd to last line remnant should read remanent.
Page 4	Chemical symbol Ze should read Zr.
" 5	Morney Dome should read Morney Anticline.
" 6	5 lines from bottom, remnant should read remanent.
Fig 9a	Trace element curve labelled Zn should read Zr.
Fig 12	Doonbarra Fm should read Doonbara Fm.
Fig 14b	Trace element curve labelled Zn should read Zr.
Fig 15	" " " " Zn " " Zr.

Add to SUMMARY Interpretations outlined in this record are preliminary in nature and are not necessary those which will appear in the final report.

1975/56

DRILLING, MEASURED SECTION, AND GEOCHEMICAL DATA ON WEATHERED PROFILES IN SOUTHWEST QUEENSLAND

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SUMMARY

This Record contains the results of field work and shallow stratigraphic drilling carried out during a study of sedimentation, weathering, neotectonics, and geomorphology in southwest Queensland. Basic data including drill logs, measured reference sections, and mineralogical data of host and weathered rocks are illustrated diagrammatically. This material is being studied in co-operation with the Geography and Geology Schools of the University of New South Wales, and a report on the relations between weathering events, contemporaneous sedimentation, folding, and landscape development is being prepared.

INTRODUCTION

Deeply weathered Upper Cretaceous and Lower Tertiary rocks cover much of southwest Queensland (Fig. 1). The objectives of the present study are to examine weathered rock sequences and their unweathered equivalents in southwest Queensland, and to study the relations between weathering events, contemporaneous sedimentation, folding, and landscape development. The late Mesozoic and Cainozoic history of the area will be interpreted in terms of sedimentation, morphology, and distribution of parent rocks and relict weathered rock profiles.

The sequences of weathered rock fall into three categories:

a. The Morney profile consisting of a trizonal profile of silicified, kaolinized, and ferruginized rocks developed in the Upper Cretaceous Winton Formation;

b. Haddon silcrete and Curalle silcrete profiles developed in the Lower Tertiary Glendower Formation;

c. The Canaway profile of indurated colluvium, which has formed from the upper part of the Morney profile and is present in places where the Morney profile has been partly eroded, subjected to further weathering, and not buried by younger Cainozic sediments. Relations between these three profiles are shown diagrammatically in Figure 2.

Because the weathered rocks extend over a very large area it was necessary to choose a representative area for detailed examination; in it the weathered rocks are well exposed and are flat-lying, gently folded, or moderately folded. Reference sections were established within the study area and in outlying areas for comparison.

The study area, approximately 11 000 km^2, is in southwest Queensland between latitude 25° and 26°30'S, and longitude 141° to 142°E (Fig. 1). South of Haddon Corner the west boundary of the study area coincides with the border between Queensland and South Australia. Field studies have involved:

a. Shallow stratigraphic drilling to obtain cores of host and weathered rock for mineralogical comparison and palynology;

b. Measurement of reference sections of the various weathered and unweathered rock profiles;

c. Representative outcrop sampling of reference sections for mineralogical studies;

d. Determination of ground surface elevations for construction of form lines and geological sections, and calculating heights of reference sections;

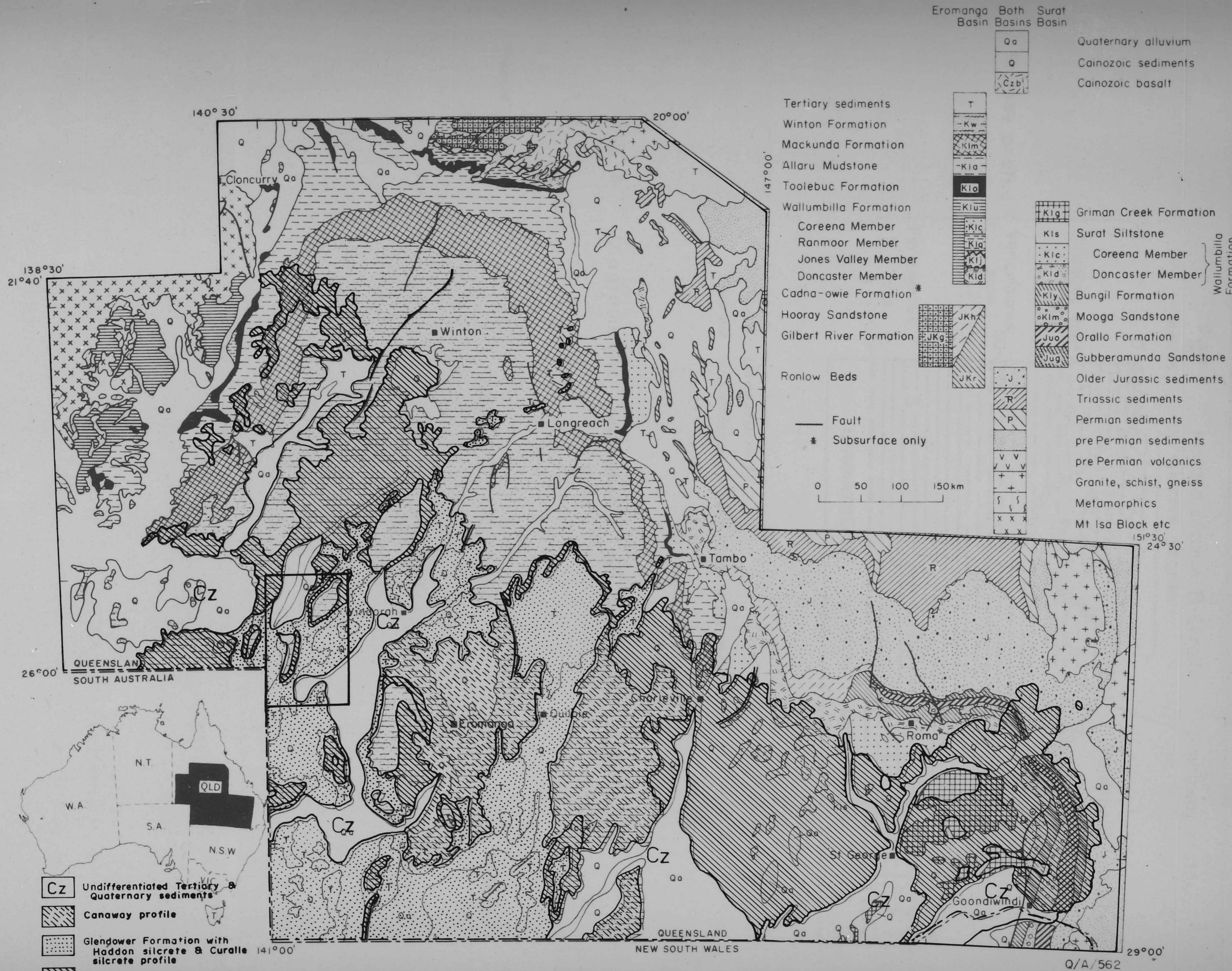


Figure 1 Generalized distribution of chemically weathered rocks in southwest Queensland

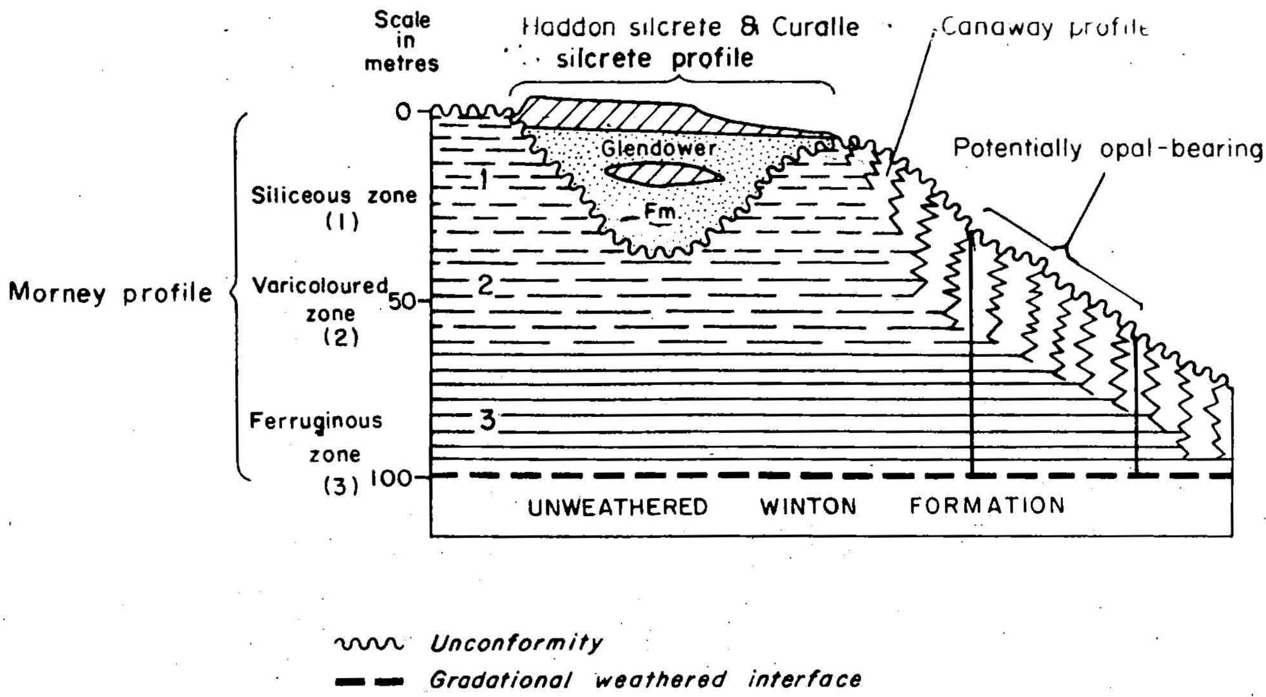


Fig. 2 Diagrammatic relationship of weathered rock units

e. Geological and photogeological mapping for construction of a 1:250 000 scale base map which combines lithostratigraphy and physiography to divide rock units;

f. Collection of orientated ferruginized rocks from weathered profiles to evaluate the potential of the palaeomagnetic method as a tool for dating of weathering events.

A 1:250 000 scale map which combines lithostratigraphy and physiography is being compiled for this area. This mapping technique gives a more detailed division of rock units than is possible with conventional lithostratigraphy and photogeology and is particularly applicable to areas of widespread surficial cover and in differentiating host and weathered rocks.

The study area lies within the arid zone of central Australia. This area is sparsely settled and beef cattle grazing is the only industry. The nearest towns are Windorah, 70 km to the east, and Birdsville, 160 km to the west. The Diamantina Developmental Road provides good access to the area, and well maintained unsealed roads link it with outlying properties. Station tracks, cleared fence lines, and seismic lines provide four-wheel-drive access to most of the area. Rainstorms usually result in boggy road conditions which can disrupt vehicle transport for several days.

DRILLING RESULTS

Six stratigraphic holes (BMR Canterbury 6-11) were drilled along a transect across the western flank of the Morney Dome. There the Morney profile and Glendower Formation with silcrete dip 1-3° to the west. At the western end of the transect the weathered rocks are concealed below Cainozoic fluvial and aeolian sediments. The objectives of the drilling were:

1. To establish the thickness of preserved weathered rocks in an environment of slight tectonic disturbance;

2. To recover cores and cuttings of chemically weathered rocks unaffected by surface weathering and pedogenic alteration.

3. To collect fresh rock from the Winton and Glendower Formations for palynology and geochemical comparison with the various weathered derivatives.

4. To determine the nature of silicification within the Glendower Formation for comparison with outcropping silcrete beds.

Table 1 summarizes the drilling results. A total of 493 m of drilling was completed of which 67 m was cored. Naming of holes is serial by 1:250 000 Sheet areas, e.g. BMR Canterbury 7 refers to the seventh hole drilled by the Bureau of Mineral Resources in the Canterbury Sheet area.

TABLE 1. RESULTS OF STRATIGRAPHIC DRILLING 1973

HOLE/LOCATION/RIG (Canterbury 1:250 000 Sheet)	ELEVATION	TOTAL DEPTH	WIRELINE LOGS	SECTION PENETRATED (Formation tops) metres	CORING AND RECOVERY %	OBJECTIVES	RESULTS
CANTERBURY NO. 6 Grid ref. 460843 Mayhew 1000	115 m	141 m	SP to 140 R to 140 Gamma-ray to 139	0 Quaternary 15 Winton Fm. (unweathered) 141 TD	7 cores Cored 20 m Recovered 18 m 90%	To obtain lithological information within the unweathered Winton Fm. for mineralogical/chemical comparison with chemically weathered equivalents .	Lignitic coal seam at 15 to 17 m Recovered sufficient core and cuttings for analyses and palynology.
CANTERBURY NO. 7 Grid ref. 450845 Mayhew 1000	103 m	90 m	SP to 89 R to 89 Gamma-ray to 85	0 Quaternary 2 Glendower Fm. 42 Morney profile 65 Winton Fm. (unweathered) 90 TD	12 cores Cored 30 m Recovered 29 m 97%	To obtain core and cuttings for clay mineralogy, chemical analyses and palynology. In addition, information on attitude, distribution and lithology of the Morney profile and silicified Glendower Fm. was sought.	Glendower Fm. was thicker than expected and overlies a truncated sequence of the Morney profile. Numerous aquifers within Glendower Fm.
CANTERBURY NO. 8 Grid ref. 445854 Mayhew 1000	137 m	94 m	SP to 93 R to 93 Gamma-ray to 92	0 Quaternary 20 Glendower Fm. 39 Morney Profile 61 Winton Fm. (unweathered) 94 TD	5 cores Cored 9 m Recovered 8 m 89%	as above	Numerous lenses and beds of silcrete within Glendower and Winton Fm. The Morney profile is progressively truncated down dip. Some aquifers in cavernous silcrete and interbeds within Glendower Fm.
CANTERBURY NO. 9 Grid ref. 453845 Mayhew 1000	109 m	93 m	SP to 94 R to 94 Gamma-ray to 93	0 Glendower Fm. 8 Morney profile 60 Winton Fm. (unweathered) 93 TD	5 cores Cored 15 m Recovered 12 m 80%	as above	Very strongly indurated surface silcrete bed. The Morney profile is 52 m thick and was the thickest encountered in this series of holes but less than the 100 m+ thicknesses measured in outcrop around the peripheral cuestas the Morney Dome.
CANTERBURY NO. 10 Grid ref. 455846 Mayhew 1000	112 m	43 m	Gamma-ray to 40	0 Morney profile 33 Winton Fm. (unweathered) 43 TD	Nil	Drilled for closer correlation between holes 6 & 7	Penetrated basal portion of the Morney profile through transitional zone into unweathered rock.
CANTERBURY NO. 11 Grid ref. 457845 Mayhew 1000	121 m	32 m	Gamma-ray to 31	0 Quaternary 3 Morney profile 26 Winton Fm. (unweathered) 32 TD	Nil	as above	as above

SP Spontaneous potential
R Resistivity

Wireline logs which include self-potential, single-point resistivity, and gamma-ray logs were obtained from most holes.

The cores and cuttings were logged at the well site using a binocular microscope, and re-examined at the Core and Cuttings Laboratory for selection of samples for clay mineralogy, major oxide, trace element, and palynological studies. Cuttings were collected at intervals of 150 cm while drilling with air, and 300 cm while drilling with water, mud, or air/water injection. All cores and cuttings are stored at the BMR Core and Cuttings Laboratory, Fyshwick, A.C.T.

Lithological and wireline logs for the six holes, together with results of clay mineralogy and major-oxide distribution where applicable, are given in Figures 3 to 8. BMR Canterbury 6 (Fig. 3) was drilled to a depth of 141 m entirely within unweathered Winton Formation, and provides a reference section for mineralogical comparison with the remaining drill holes, all of which intersected the chemically weathered profile in this unit. All holes bottomed in unweathered Winton Formation.

REFERENCE SECTIONS OF WEATHERED ROCKS

Information from shallow stratigraphic drilling was supplemented by measuring outcrop sections. The objectives of this work were:

1. To determine if the mineralogy of rocks in outcrop differs from that of equivalent rocks below the depth of superficial weathering;

2. To ascertain thickness variations within individual profiles;

3. To determine the lateral extent of weathering profiles at various locations.

Outcrop sections were found that were as good as, or superior to, those obtained from drill holes. Mineralogical work showed that there is little advantage in resorting to drilling because differences between outcrop and subcropping weathered rock units are insignificant. However, the most valuable information from drilling was to establish the thickness of concealed profiles. It is thought that variations in thickness can be correlated with the position of the profiles relative to the original weathering land surface.

DETERMINATION OF GROUND SURFACE ELEVATION

Barometric loop traverses were made between known elevations of gravity stations. These data were combined with elevations of seismic shot-points and trigonometrical stations to compile a form line map at 1:250 000 scale, contoured at five-metre intervals. This diagram (not included in this Record) provides surface control for construction of a series of geological sections depicting the spatial distribution of weathered profiles.

ANALYTICAL RESULTS

The bulk of the analytical data is plotted in graphic form accompanying text figures 3, 4, 5, 9, 10, 11 & 15. Most of the clay mineralogy, major-oxide, and trace-element work was carried out by AMDEL (Reports MP3716/74, MP2691/74, and MP340/75). Copies of these reports are lodged in the BMR Stratigraphic Index in the Canterbury 1:250 000 Sheet area.

1. The Morney profile

Good exposures of the Morney profile occur in the vicinity of the Three Sisters Mountains. A reference section from the southernmost mountain of this group has 90 m of almost continuous exposure of this profile (Fig. 9). This section was spot sampled initially by collecting one sample every 4 m, and the material was studied with a view to establishing zonation of clay mineral species and silica, alumina, and iron oxides. Following promising initial results the section was resampled by dividing it into 3 m intervals using numbered steel marker pegs. For each interval a similar sized sample was taken from all arenite and all lutite beds. In the laboratory each suite of samples was coarsely crushed to approximately granule size and a representative sample was subjected to further crushing prior to major-oxide analyses and analyses for four trace elements (Ze, Ba, Cr, V). The curves obtained for silica alumina, and iron oxides (see Fig. 9A) show that overall profile development was indicated by spot sampling (Samples 21/1-17) though a more accurate and complete result was obtained from the second suite of samples (Samples 39/1-25). In the latter case there is no need to differentiate between arenites and lutites as they are chemically similar.

The distribution of silica, alumina, and iron oxides confirms the observed gradational trizonal nature of the Winton Formation profile. There is a ferruginous zone at the base and a siliceous zone at the top, with a medium gradational zone. Alumina remains constant or increases slightly upwards. Analysis of spot samples from neasured sections near Mount Butler (Fig. 10) and near Mount Flat Top (Fig. 11) confirmed these trends.

2. Glendower Formation and silcrete profiles

Two broad groups of silcretes were mapped in the Glendower Formation: those sandwiched between unaltered rock (Haddon silcrete profile), and those with subjacent weathered zones (Curalle silcrete profiles).

(a) Haddon silcrete profile

In this category are massive silcretes which closely follow the bedding geometry of the host rocks and appear to have formed by silica-bearing groundwater moving laterally and silicifying permeable sediments. They are replacement phenomena associated with silicification of well sorted quartzose sandstone on dip slopes. They do not have weathered rocks in juxtaposition and have sharp contacts with unaltered rock. In outcrop they generally consist of extremely hard silcrete beds (Fig. 12) 0.5 to 15 m thick and are selectively silicified in conformity to former porous and permeable lenses and beds of the host rock. Down-dip within thicker sections of host rock several distinct beds of silcrete are present (Fig. 13). Several broad zones of silicification were found in BMR Canterbury 8 (Fig. 5). Drilling and seismic work along the east flank of the Morney Dome (Senior, in press) showed that silicification decreases down-dip in an intertonguing relationship with the host rock. Silcretes without profiles probably formed by radial migration of silica-laden groundwater towards synclines. Most of the silica was deposited in the margins of these depressions, and owing to a lack of silica or an unfavourable chemical environment the axes contain unsilicified rocks. The silicified margins to these depressions have become selectively eroded to form cuestas, and the dips observed may reflect the initial slopes along which siliceous water moved and transformed suitable beds into silcretes.

(b) Curalle silcrete profile.

In this category are blocky nodular and stumpy columnar silcretes which grade down into less siliceous, sheared and strongly brecciated sediments.

A zone of iron-oxide mottling forms a basal transition to unaltered rocks. This type of silcrete formed mainly in argillaceous quartzose sandstone of the Glendower Formation (Fig. 14) or less commonly in the quartz-poor Morney profile.

3. Canaway profile

Regional mapping has shown that an indurated, iron-oxide-rich brecciated crust up to 15 m thick occurs in those parts of the landsurface which were not covered by fluviatile sedimentary rocks (Glendower and Whitula Formations). In these areas pedogenic processes acted on the Morney profile, and by a process of intense brecciation and iron-oxide cementation formed a hard crust (Canaway profile) which grades down through a mottled zone into remnants of the older Morney profile. A feature of the Canaway profile is its well developed macrocolumnar structure, which is clearly seen in indurated cappings of plateaux and mesas (Fig. 15).

Depostis of precious opal are found in areas where the Canaway profile formed. This association suggests that opal 'mineralization' is in some way related to further prolonged weathering which formed this crust. Dating opaline silica by the potassium-argon method may offer independent evidence as to the age of the weathering event that formed this profile. Three samples have been submitted to AMDEL to investigate the suitability of this material for potassium-argon dating.

PALAEOMAGNETIC STUDY

Introduction

Eleven orientated outcrop samples of ironstone were collected across a 550 km wide zone from near Lake Machattie southeast through Haddon Corner to Eulo (Fig. 16). Dr M. Idnurm (Geophysical Branch, BMR) measured the magnetic properties of these rocks and found that ten of the samples have constant palaeomagnetic directions and one was spurious. The consistency in measured remnant directions indicates that it is possible to use palaeomagnetic methods for age determination of weathered rock profiles in the Eromanga Basin. Further sampling is required to obtain sufficient measurements to establish the time span of weathering events. The time interval segments can then be related to a published polar wander curve.

Method

Samples will be taken at the same location. A sun compass will be used to orient samples. It is well known that lightning strikes, and recrystallization of iron minerals by hydration, can re-orient the magnetic field in outcrop samples. Such spurious effects can be detected by collecting at least three widely spaced samples from the same locality. Weathering effects are checked by systematic demagnetization of pilot specimens.

Interpretation

If weathering was episodic the pole data would plot around a point; if it took place over an interval of at least 10^5 years the pole data would plot along a curve (a segment of the polar wander curve). In the latter case some estimate of the time span for weathering could be calculated from the length of the segment.

Preliminary results from samples collected from the Morney profile lie in two groups on the polar wander curve. Samples from the Lake Machattie area are apparently older than those from Haddon Corner. The indicated time span of weathering from the Morney profile is between 35 and 45 m.y. (late Eocene). This result is tentative because the samples were few and were not collected strictly in accordance with procedures outlines above. This tentative age of the Morney profile is consistent with the youngest age determined for the parent Winton Formation by palynology (Cenomanian, Dr D. Burger pers. comm.) and a K-Ar dating of the basalt intrusion into this profile (Miocene; Exon et. al., 1970). The palaeomagnetic evidence conflicts with the supposed age of the overlying Glendower Formation, which is regarded as early Tertiary on inconclusive stratigraphic evidence. However, correlation of geomorphic surfaces and weathering events on a regional scale (including the northern part of the Eromanga Basin and Carpentaria Basin) shows promise of independent evidence that is compatible with the priliminary palaeomagnetic results.

REFERENCES

SENIOR, B.R., in press - Silcrete and chemically weathered sediments in southwest Queensland; in AUSTRALIAN SILCRETES. Uni. New England Monograph Ser.

EXON, N.F., LANGFORD-SMITH, T., & McDOUGALL, I., 1970 - The age and geomorphic correlations of deep-weathering profiles, silcrete, and basalt in the Roma-Amby region, Queensland. J. Geol. Soc. Aust., 17(1), 21-30.

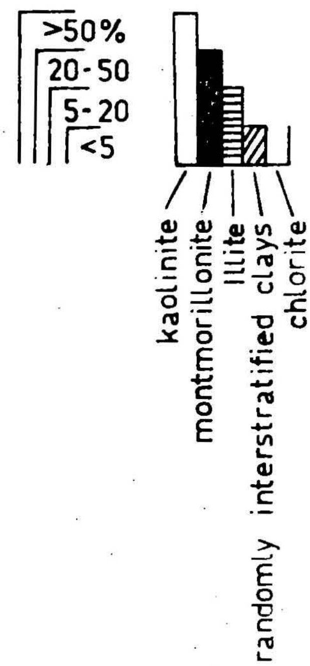
TABLE 2 ABBREVIATIONS USED ON LITHOLOGICAL LOGS AND REFERENCE SECTIONS

Above	abv
Abundant	abd
Altered	altd
And	&
Angular	ang
Black (ish)	blk, (blk)
Blue (ish)	bl, (bl)
Brown (ish)	brn, (brn)
Calcareous	calc
Carbonaceous	carb
Coarse	c
Chemically	chem
Chlorite	C
Clinoptilolite	CL
Conglomerate	Cong
Dark	dk
Fair	fr
Feldspar	Fld
Fe minerals	Fe
Ferruginous	fe
Fine	f
Friable	fri
Glauconie	Glau,
Goethite	G
Grained	grnd
Grey (ish)	gy, (gy)
Green (ish)	gn, (gn)
Gypsum	Gyp
Hard	hd
Illite	I
Interbedded	intbdd
Intercalated	intcld
Kaolinite	K
Kaolinitic	Kaol
Laminae	lam
Laminated	lamd
Light	lt
Limestone	Lst
Matrix	mtx
Medium	m
Mica (ceous)	Mic, mic
Moderate	mod
Montmorillonite	Mo
Mudstone	Mdst
Opaline silica	O
Olive	olv
Mottled	Om
Orange	orng
Pale	pl
Pink (ish)	pk, (pk)
Poorly	py
Purple	purp
Pyrite	Pyr
Quartz	Qz
Quartzose	qzs
Randomly inter-stratified clays	RI
Rounded	rndd
Sand (y)	Sd, sd
Sandstone	Sst
Secondary	sec
Silcrete	Sil
Siltstone	Sltst
Siliceous	silic
Soft	Sft
Soil	Sl
Sorted	srtd
Staining (ed)	Stng stnd
Subangular	subang
Subrounded	subrndd
Very	v
Weathered	wthrd
Well	w
White (ish)	wh, (wh)
With	$\bar{c}$
Yellow (ish)	yel, (yel)

BEDDING STRUCTURES

- bioturbation
- concretions
  - f ferruginous
  - c calcareous
- cutans
- mudclast (rounded)
- mudclast (angular)
- parallel lamination
- cross stratification (solitary)
- cross stratification (group)
- undulose
- scour & fill
- slumped
- Om mottled
- remnant bedding trace
- joints & cracks

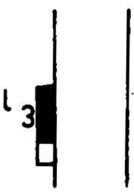
CLAY MINERALOGY



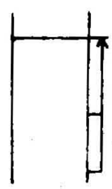
BED THICKNESS

very thick		>120 cms
thick		60 - 120
medium		5 - 60
thin		1 - 5
laminate		<1

DRILLING DATA



GROUNDWATER



LITHOLOGICAL SYMBOLS

- sandstone
- pebbly sandstone
- conglomerate
- sandy limestone with clasts
- silcrete
- siltstone
- mudstone
- ferruginous layers
- limestone or calcareous sandstone
- lignite

FOSSILS

- plant fossil
- fossil wood
- spore or pollen

Figure 3 BMR Canterbury 6

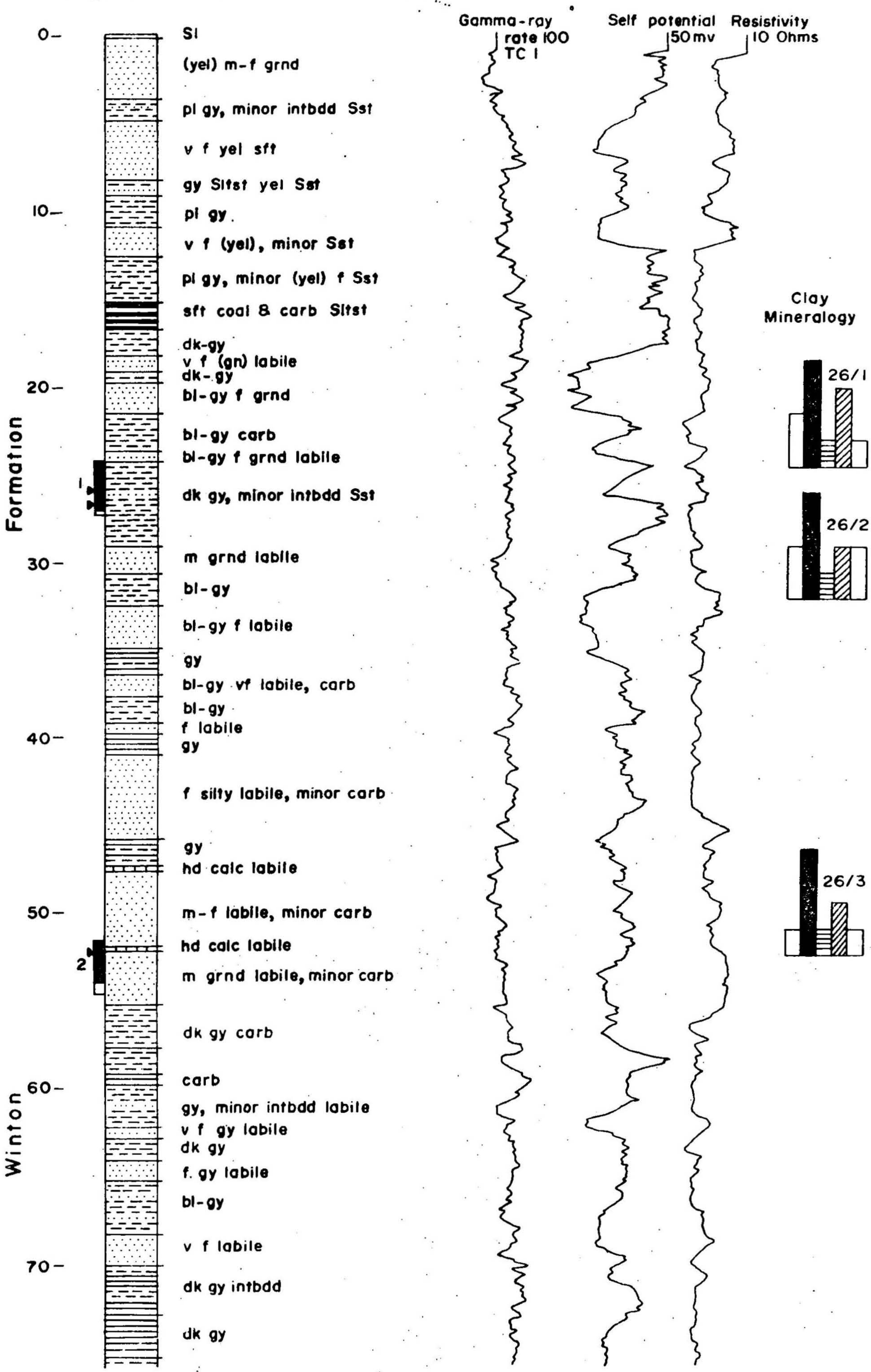


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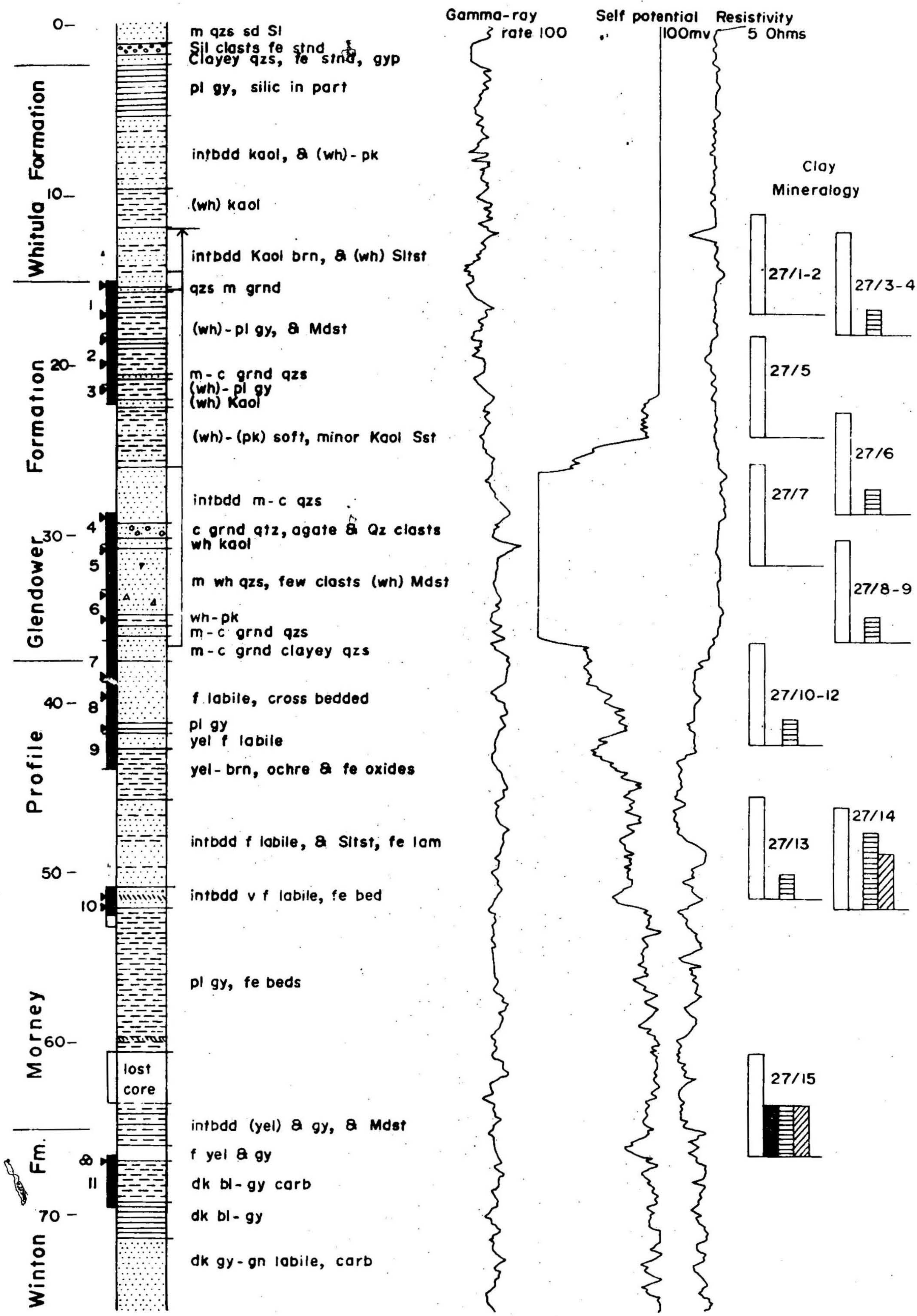
Figure 4 BMR Canterbury 7



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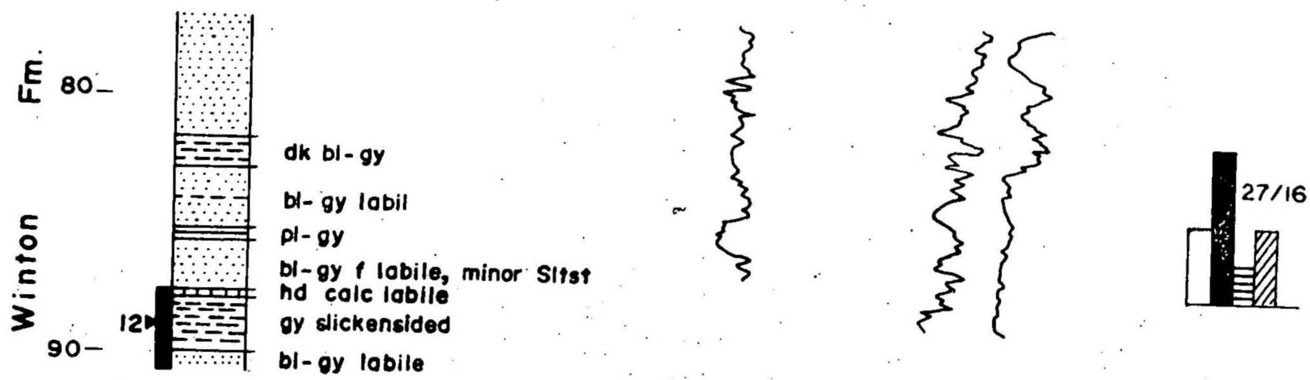
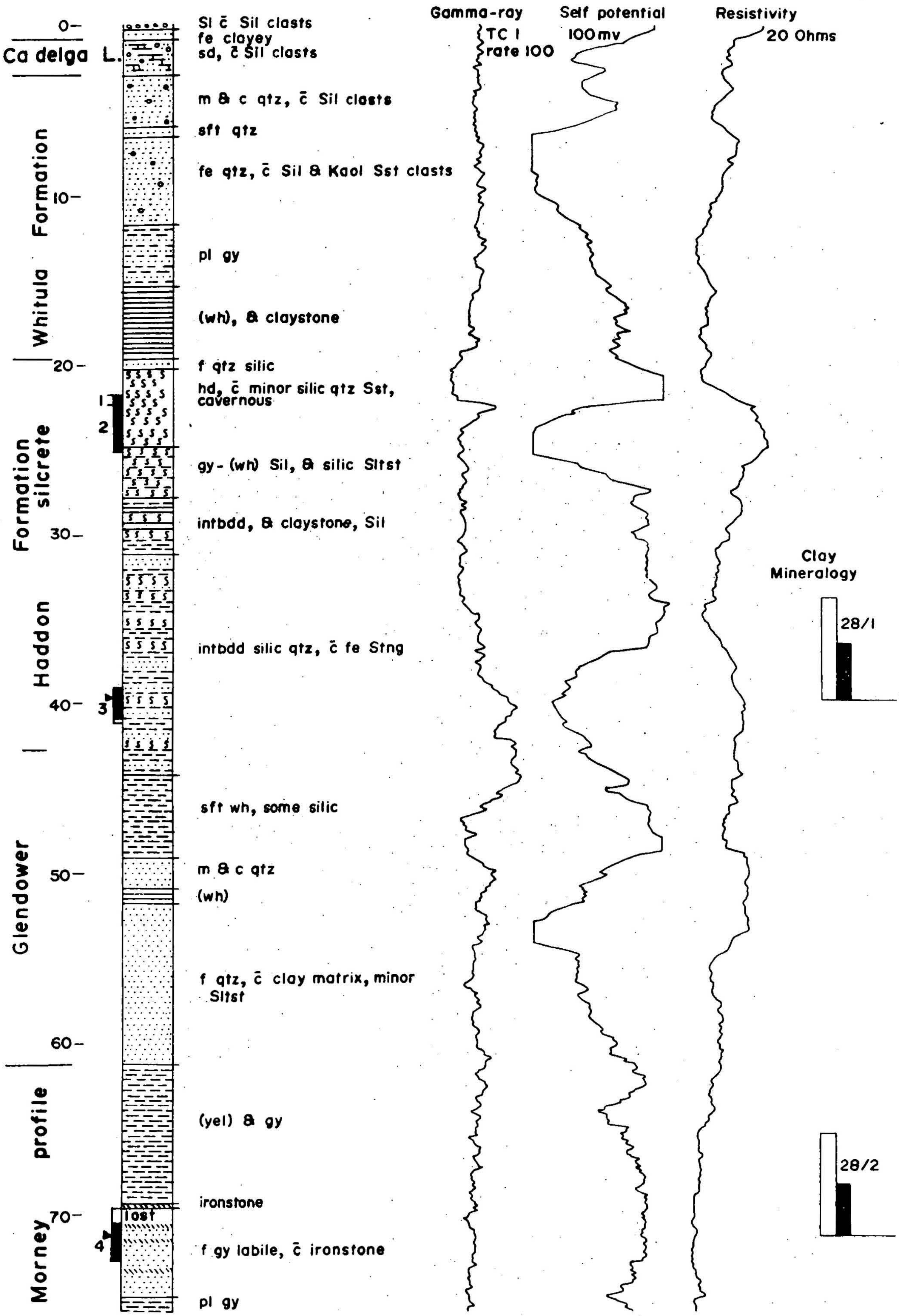

Winton Fm.
80
90
12
dk bl-gy
bl-gy labil
pl-gy
bl-gy f labile, minor Sltst
hd calc labile
gy slickensided
bl-gy labile
27/16

Figure 5 BMR Canterbury 8



BMR Canterbury 8 (continued)

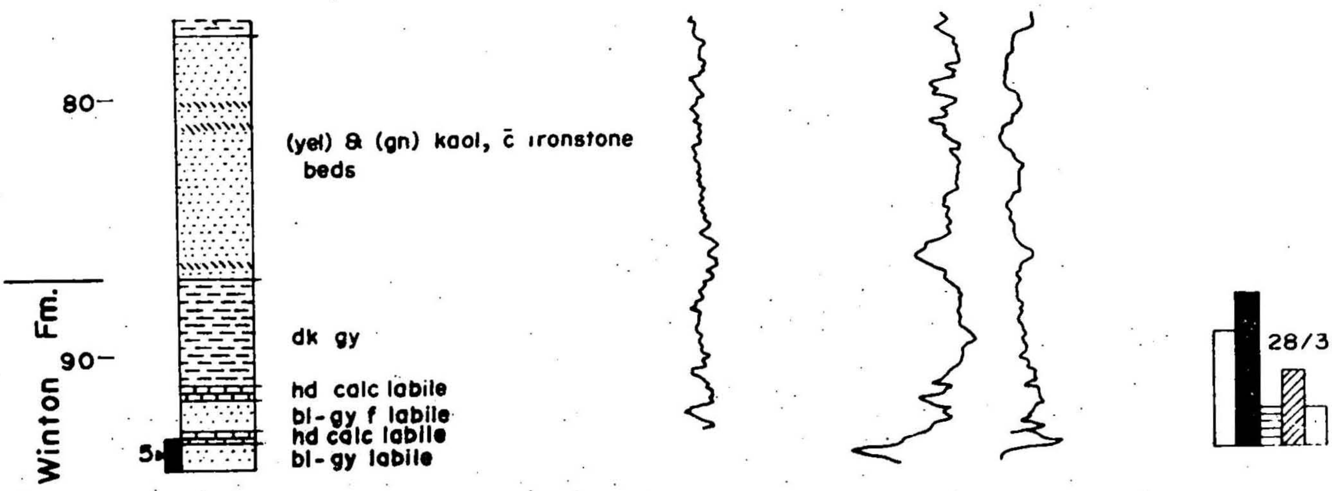
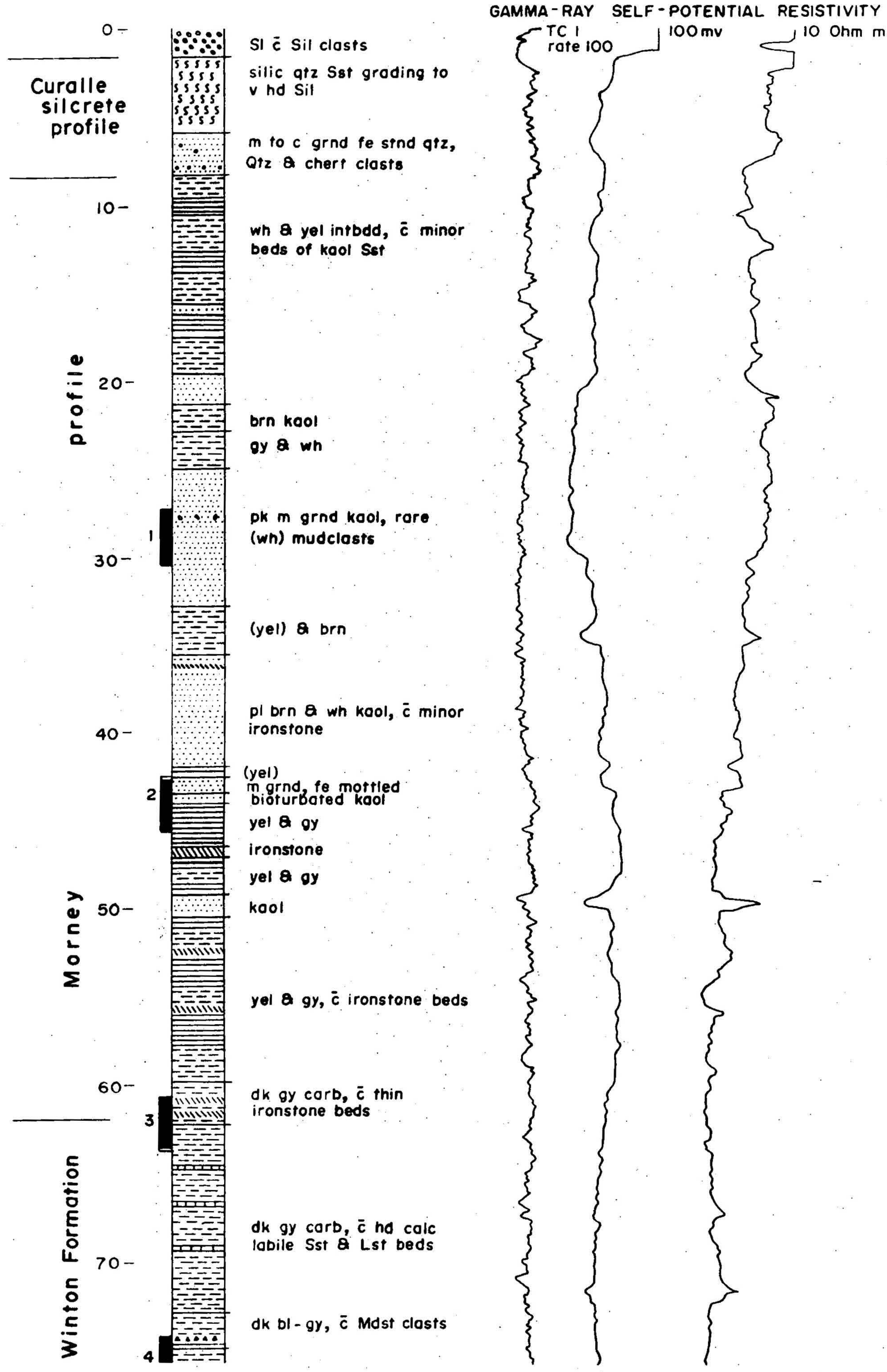


Figure 6 BMR Canterbury 9



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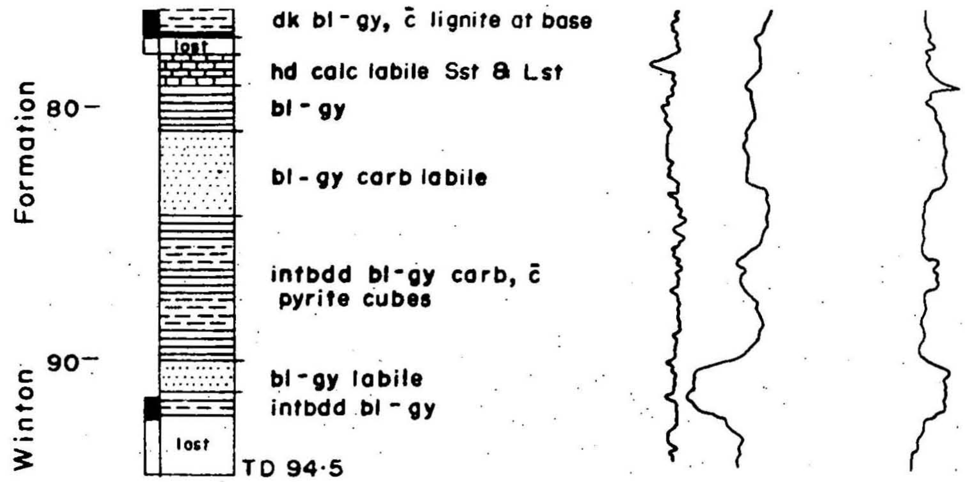


Figure 7 BMR Canterbury 10

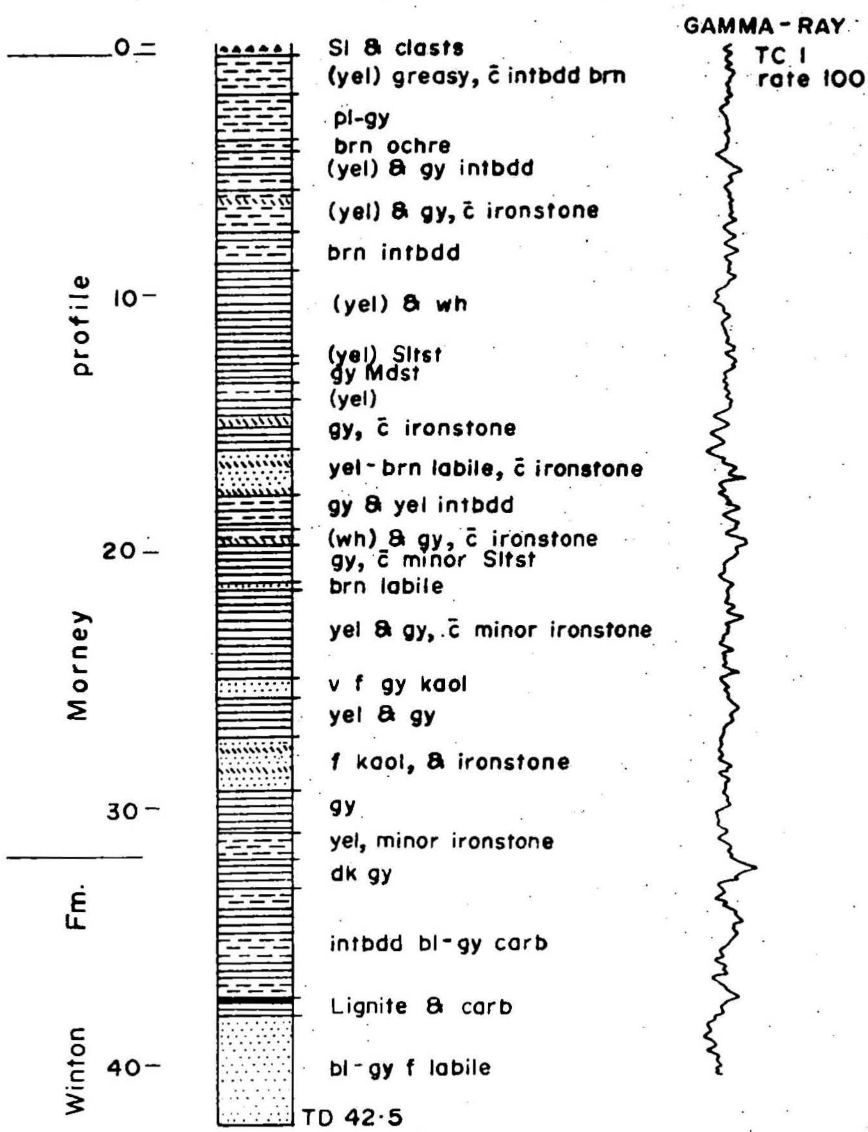


Figure 8 BMR Canterbury 11

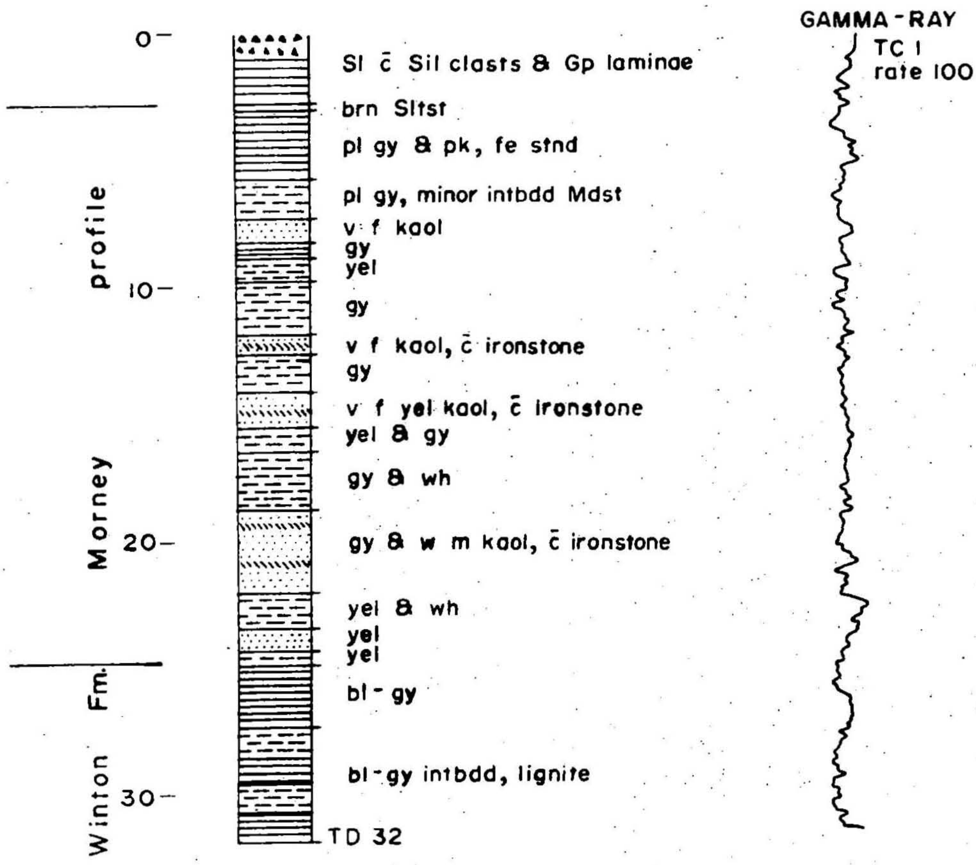
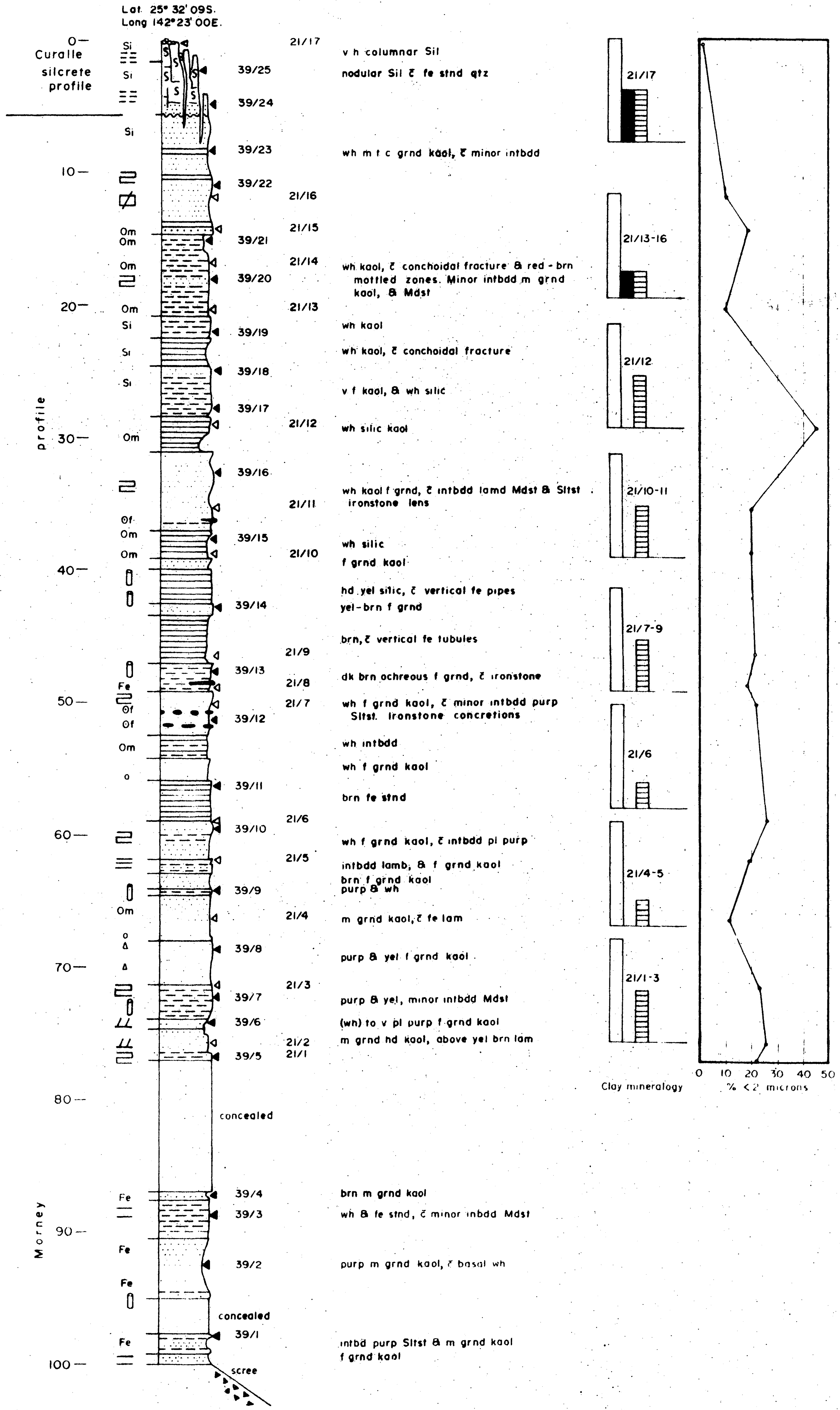


Figure 9 Reference section of the Morney profile at the Three Sisters Mountains, showing the distribution of clay minerals



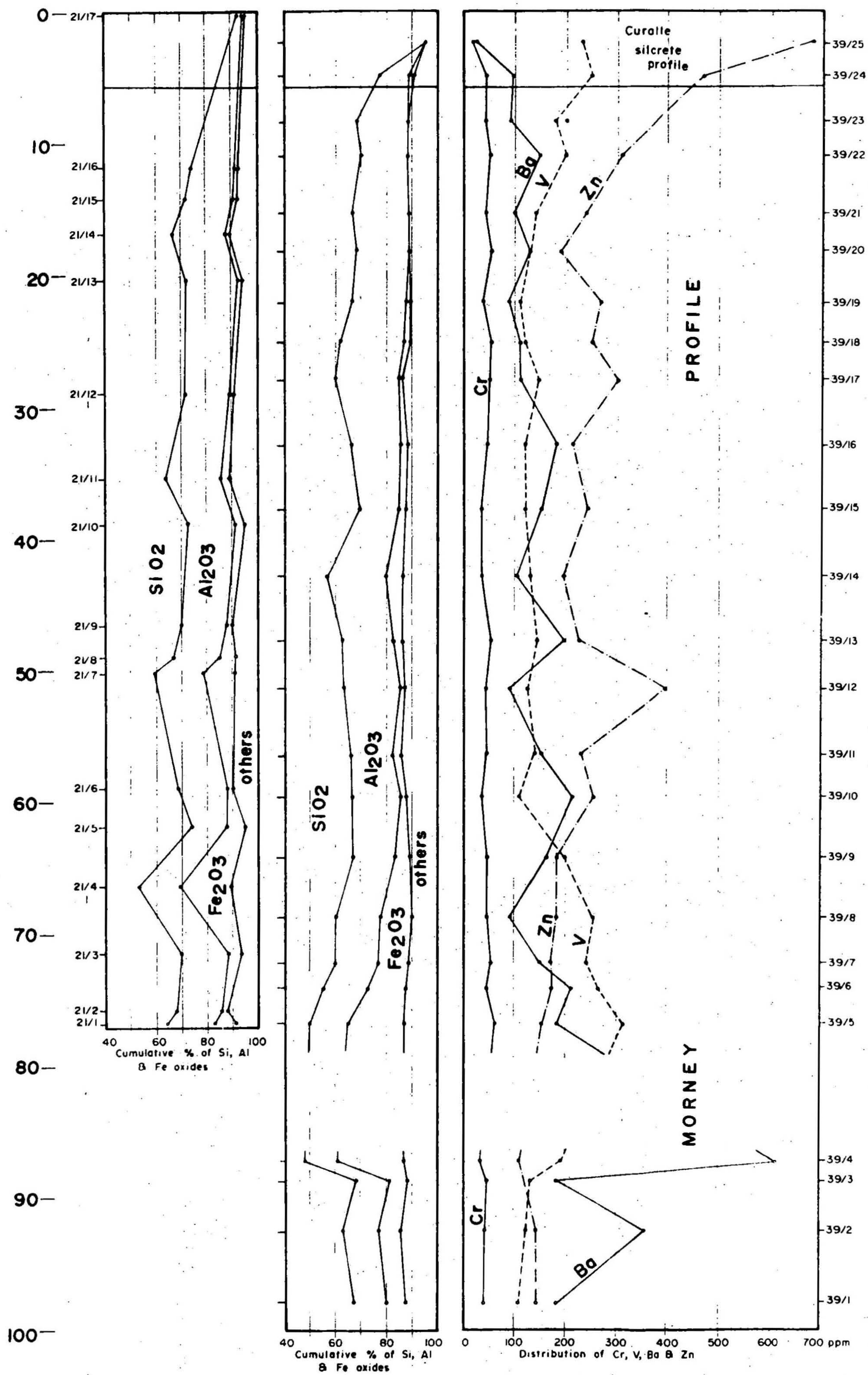


Figure 9A Major oxide and trace element distribution at the Three Sisters Mountain reference section

Figure 10 Morney profile and Curalle silcrete profile supplementary reference section. Locality near Mt. Butler.

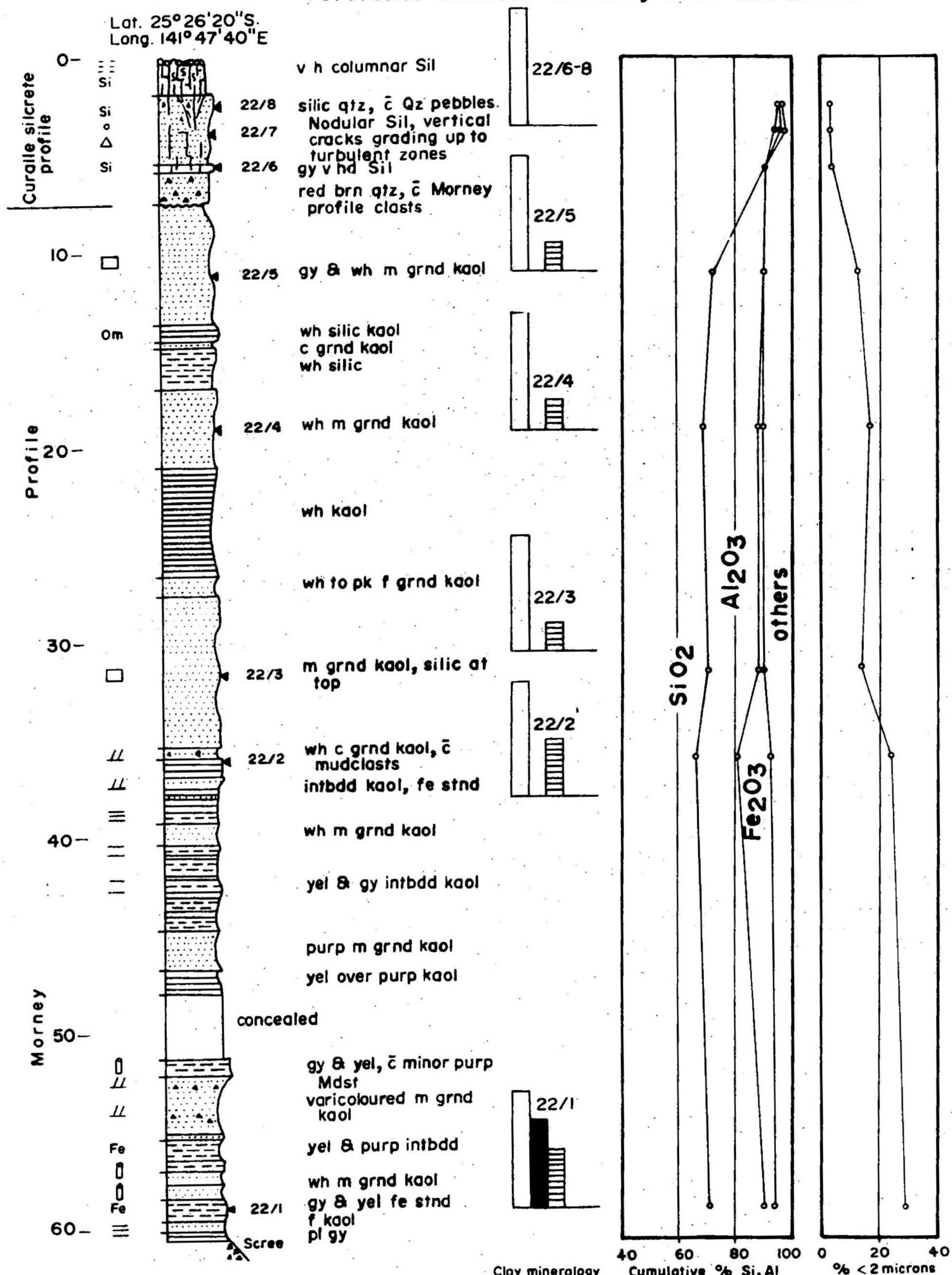
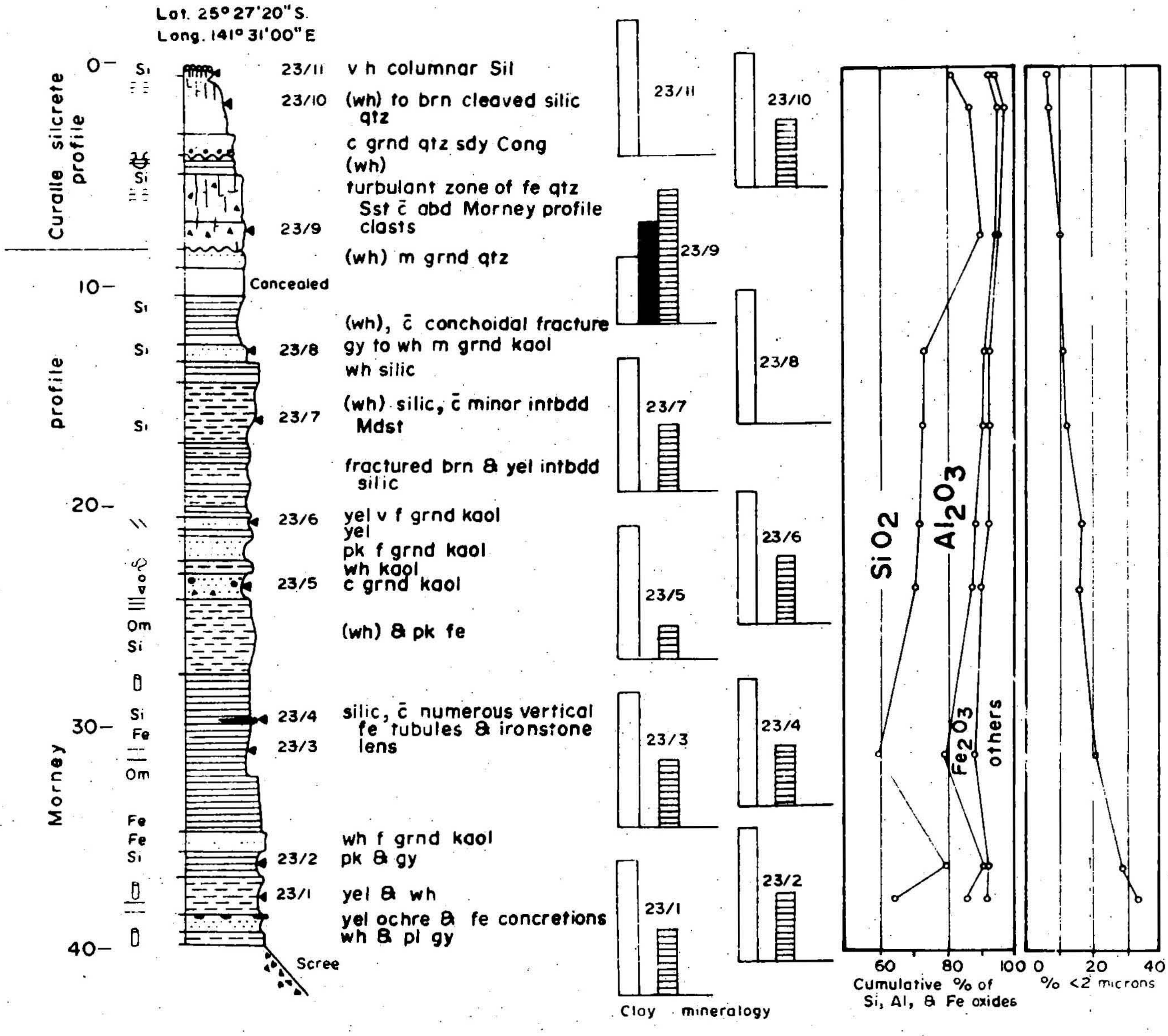


Figure 11 Morney profile and Curalle silcrete profile supplementary reference section. Locality near Mt. Flat Top



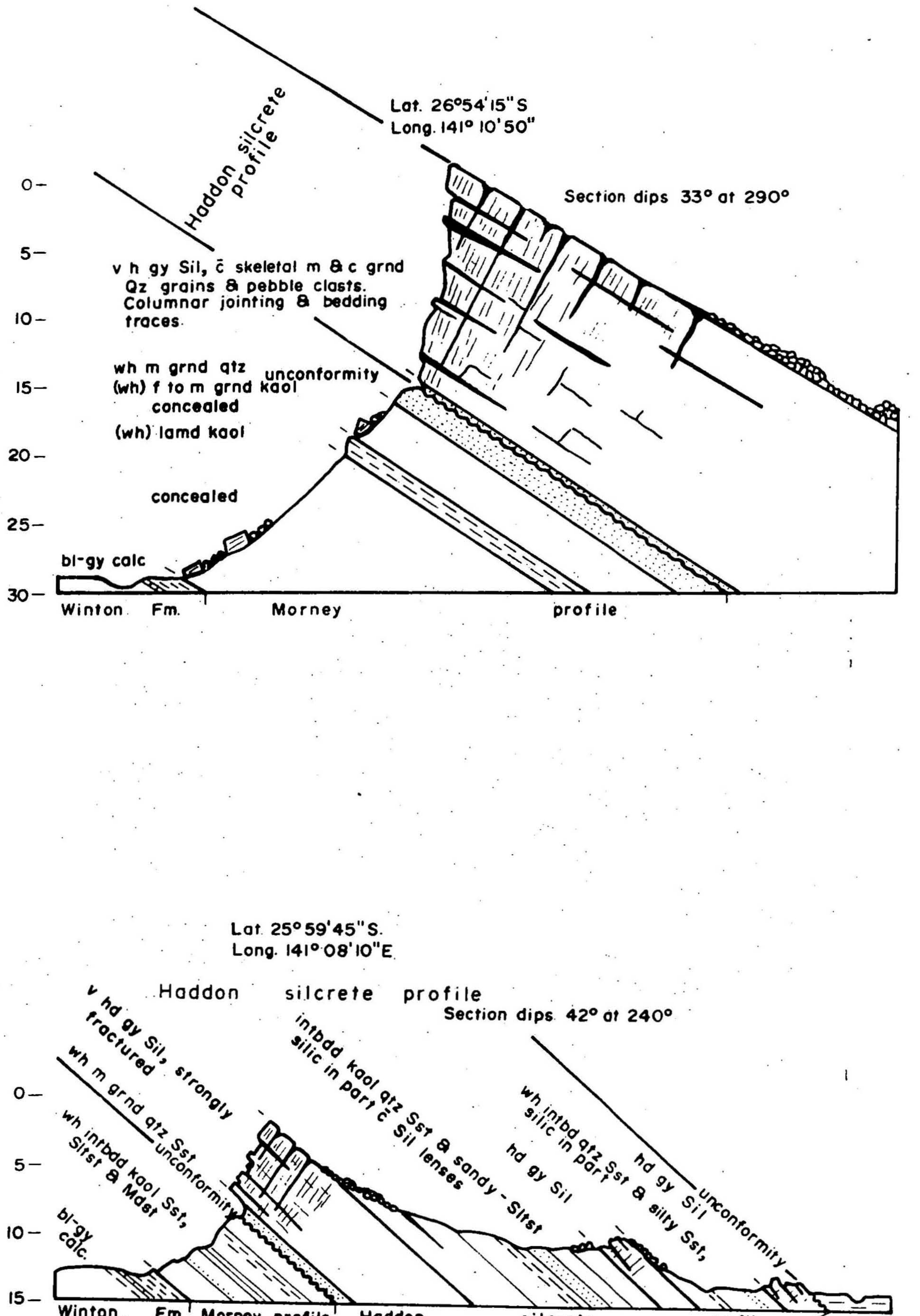


Figure 12 Haddon silcrete profiles located along the west limb of the Curalle Dome

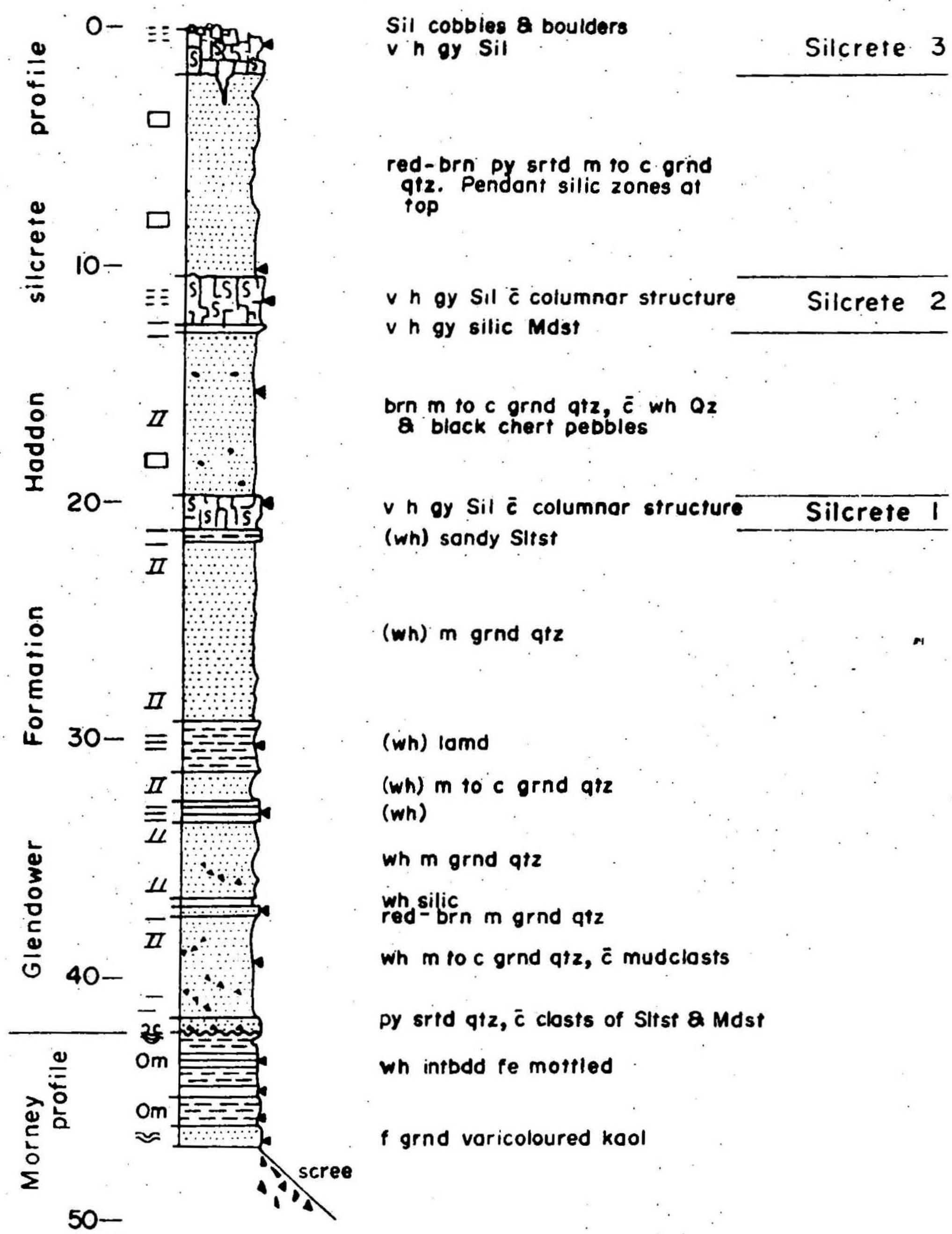


Figure 13 Reference section of the Haddon silcrete profile.

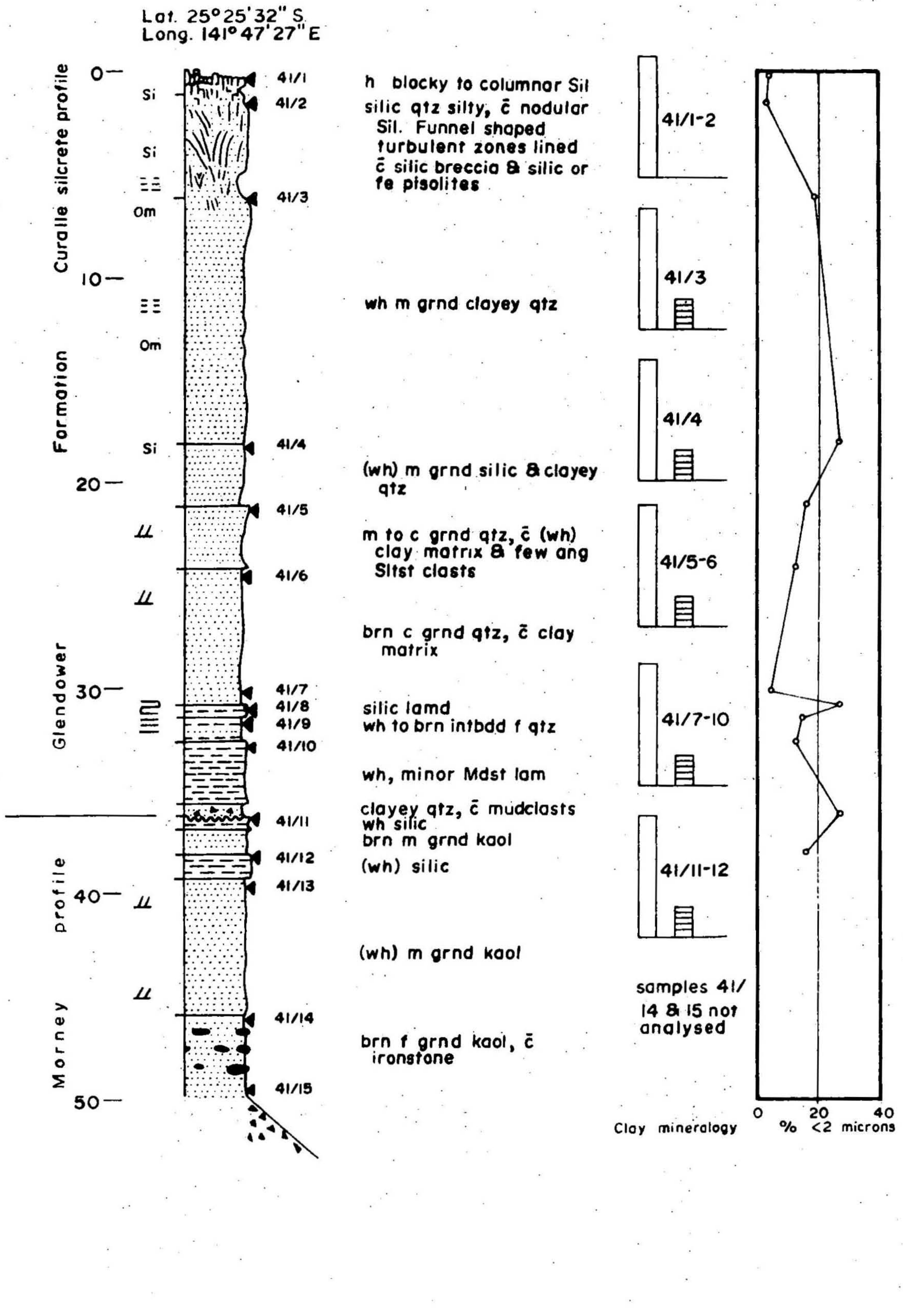


Figure 14 Curalle silcrete profile reference section showing the distribution of clay minerals.

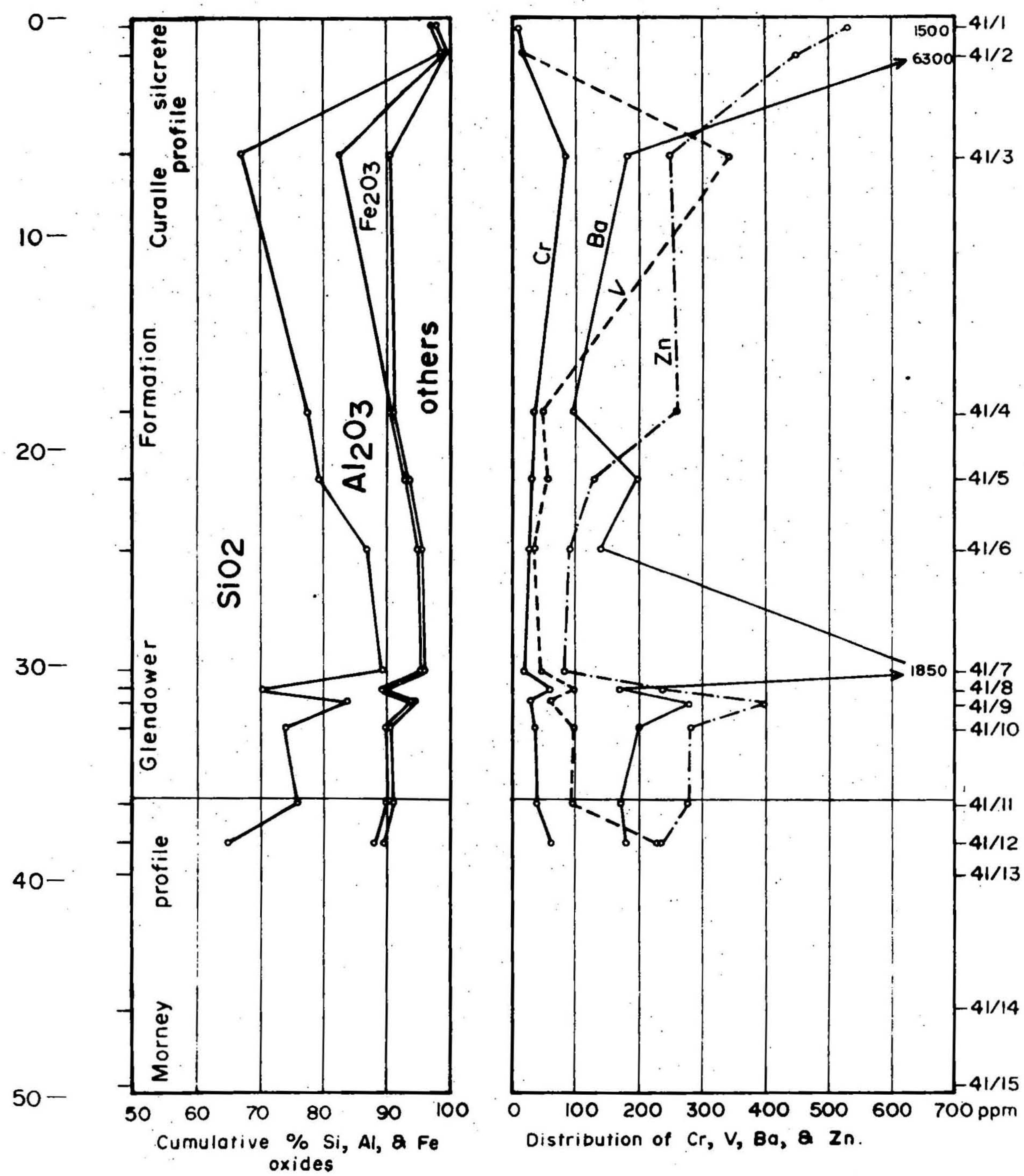
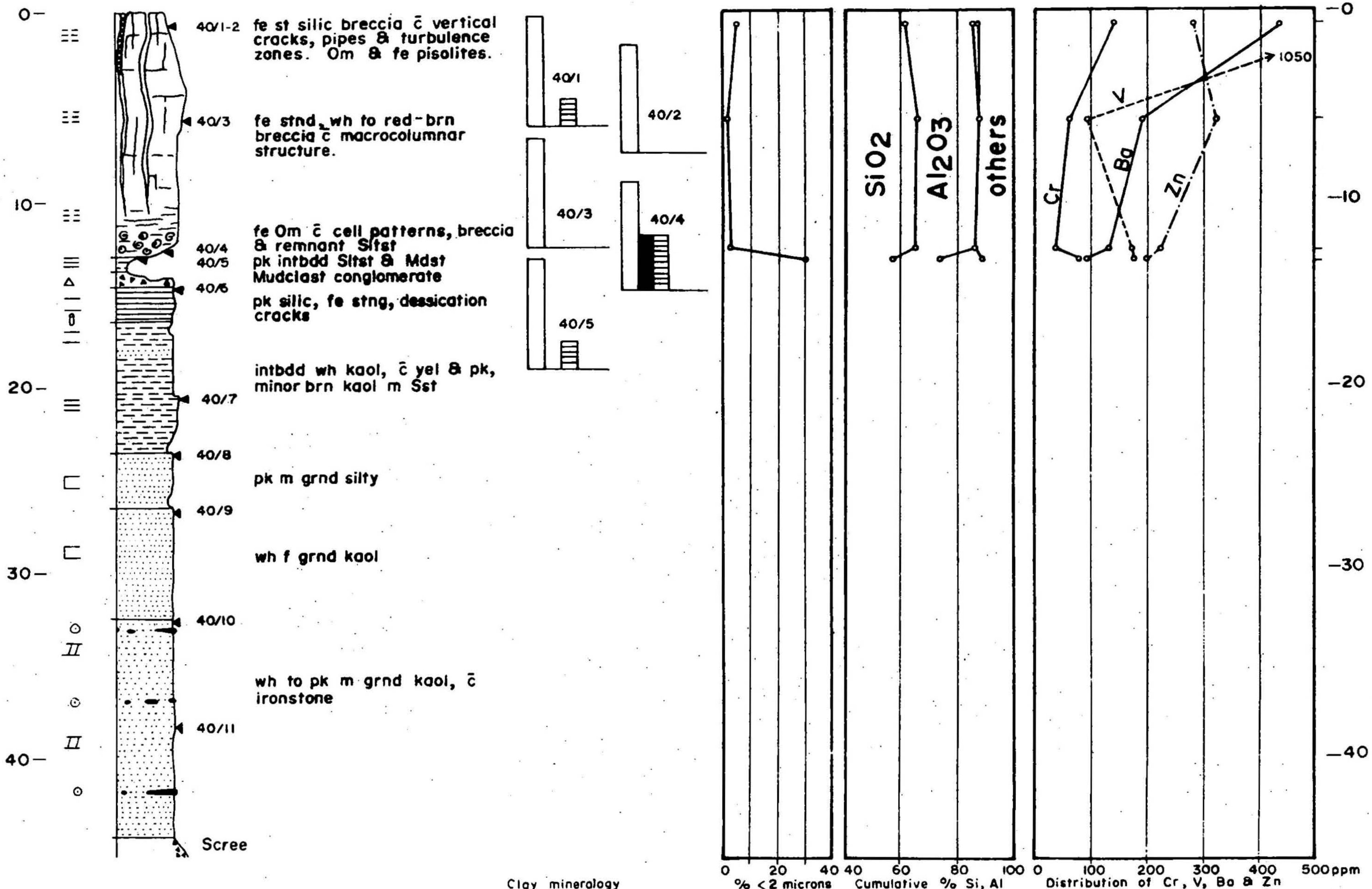


Figure 14B Major oxide and trace element distribution at the Curalle silcrete profile reference section.

Figure 15 Canaway profile reference section near Mt. Canaway, showing the distribution of clay minerals, major oxides and four trace elements.



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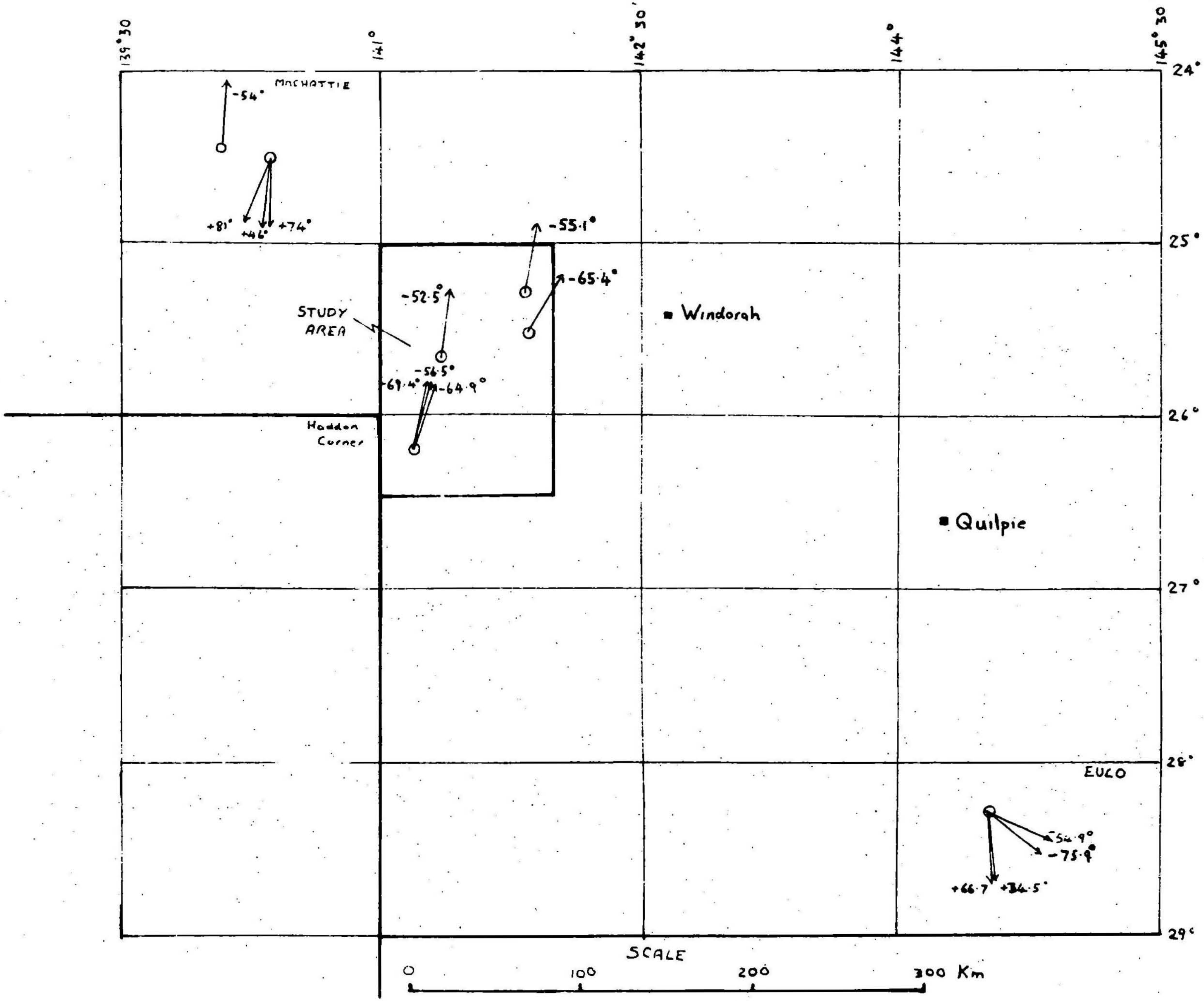

-65°

Fig 16

ORIENTED SAMPLE SHOWING REMANENT MAGNETIZATION INCLINATION AND DIRECTION

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