R. Rainbird

EXCURSION 16B: PRECAMBRIAN GEOLOGY OF THE COBALT AREA, NORTHERN ONTARIO

by

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one metre wide were encountered. Some of these proved to contain assemblages consisting entirely of native silver and silver arsenides.

GEOLOGY OF THE COBALT AREA

ARCHEAN VOLCANIC ROCKS

Massive and pillowed basalts and andesites in the Cobalt area form part of the Abitibi Greenstone Belt (Goodwin and Ridler, 1970) the largest of the Archean supracrustal belts in the Superior Province. These volcanic rocks have been isoclinally folded along easterly trending axes, and have been metamorphosed to greenschist facies. Black shales and tuffs are locally interbedded with the volcanic strata. Felsic volcanic rocks, less abundant than mafic volcanic rocks in the greenstone belts, typically occur in the upper parts of mafic-to-felsic cycles. Several distinctive textural varieties, such as porphyritic dacites and rhyodacites with resorbed quartz phenocrysts, provide distinctive markers. Intrusive equivalents of the flows occur as hypabyssal plutons and dykes. In spite of widespread penetrative deformation, primary structures and textures are generally well preserved.

ARCHEAN SEDIMENTARY ROCKS

Most sedimentary rocks (arenites, wackes, conglomerates and argillites) associated with volcanic rocks of the Abitibi Greenstone Belt belong to the Timiskaming Group (Stockwell et al, 1970). A preponderance of volcanic clasts in the Timiskaming conglomerates establishes an unconformable relationship to the volcanic rocks but, as in most greenstone belts, a simple two-fold subdivision merely masks the complexity

TABLE 1

STRATIGRAPHIC COLUMN, COBALT AREA

PHANEROZOIC	Recent		Fluvial and lacustrine deposits
	Pleistocene		Glacial sand, gravel and varved clay
	unconformity		
	Silurian	Thornloe Formation Wabi Formation	Dolomite, limestone, Limestone, shale
	disconformity		
	Ordovician	Dawson Point Formation Farr Formation Bucke Formation Guigues Formation	Shale Limestone Shale Sandstone
	unconformity		
PROTEROZOIC		Olivine and quartz diabase	
	intrusive contact		
		Nipissing diabase	
	intrusive contact		
	Huronian Supergroup	Cobalt Group Lorrain Formation Gowganda Formation Firstbrook Member Coleman Member	Quartz arenite, arkose Argillite Conglomerate, sandstone, argillite
	unconformity		
ARCHEAN		Diabase, minor lamprophyre	
	intrusive contact		
	Algoman	Granite, granodiorite, syenite	
	intrusive contact		
		Dykes and sills of mafic and ultramafic rocks; lamprophyre	
	intrusive contact		
	Timiskaming	Lithic and feldspathic arenites and wackes; conglomerate	
	unconformity		
	Keewatin-type Volcanic Rocks	Mafic to intermediate mafic flows and tuffs; felsic flows and pyroclastics; minor interflow sediments (mainly black shale and chert); iron formation. volcanic rocks	

of Archean events. Although the term "Timiskaming" is appropriate locally insofar as this is the type area for these Archean sediments, extrapolation to other greenstone belts is unjustified, as is extension of the term "Keewatin" to volcanic rocks of scattered greenstone belts that resemble those in the type Keewatin area near the Ontario-Manitoba border.

The Timsikaming sedimentary rocks are atypical of Archean clastic sediments, which in most greenstone belts show ample evidence for deposition by turbidity currents. The Timsikaming sediments are replete with structures that indicate shallow-water, probably terrestrial, deposition.

Associated with volcanic rocks in the Temagami area are Algoma-type banded iron formations typical of Archean terranes. These sediments display characteristics of chemical sedimentation, but also show features indicative of reworking by bottom currents. Although the iron formation at Temagami has been extensively folded, small-scale folds of penecontemporaneous origin also can be recognized.

PROTEROZOIC GEOLOGY

Regional geology of the Huronian Supergroup, outlined in a classic report by Collins (1925), has been reviewed in more recent papers by Young (1971), Young and Church (1966) and Frarey and Roscoe (1970). The stratigraphy has been discussed by Church and Young (1970), Robertson (1973), Robertson et al (1973) and Roscoe (1969, 1973). Only the uppermost of four cycles, the Cobalt Group, is represented in the Cobalt area (Table 2). Strata of the Cobalt Group are horizontal to gently folded, but have been broken by numerous steep faults. The rocks range from unmetamorphosed to greenschist facies. Metamorphic effects are most pronounced near contacts with sills of Nipissing Diabase (Jambor, 1971b).

Gowganda Formation

The Gowganda formation consists mainly of paraconglomerates of probable glacial origin. In the Cobalt area, Thomson (1957) has subdivided the Gowganda into two units, which are here designated as members of the Gowganda Formation (following Jambor, 1971a).

Coleman Member

The Coleman Member consists of polymictic conglomerates that rest unconformably on the Archean basement. A regolith is locally preserved at the base of the Coleman (Patterson, 1979; Rainbird, 1980); overlying conglomerate units range from paraconglomerates (inferred to be tillites) to orthoconglomerates (interpreted as glacio-fluvial outwash). Arenites are intercalated with the orthoconglomerates; argillites which contain scattered dropstones are inferred to be of glacio-lacustrine origin. The clasts in the conglomerates display a wide range in size, shape, roundness and composition. Virtually all Archean rock types are represented, with some units being characterized by distinctive abundances of clasts.

Firstbrook Member

The Firstbrook Member consists of argillites not unlike those in the underlying Coleman Member, except that dropstones are rare, and the colour is generally mauve to pink, in contrast to the dull green colours of the Coleman argillites. Soft-sediment deformation is common, and an example of sandstone injection will be seen during the excursion.

Lorrain Formation

The Lorrain Formation is the uppermost unit of the Cobalt Group in the Cobalt area. It consists of well-indurated quartz arenite and feldspathic arenite characterized by abundant crossbedding. Terrestrial to deltaic and shallow-marine environments of deposition have been suggested by Hadley (1968, 1969).

Nipissing Diabase

The Nipissing Diabase occurs as thick sills that have mainly intruded strata of the Cobalt Group, but the sills locally transect Archean basement rocks (Hriskevich, 1968; Card and Pattison, 1973). The diabase of this unit shows typical ophitic texture, and displays mineralogical differentiation. Granophyric zones occur locally in upper parts of the sills. The silver-arsenide veins of the Cobalt area appear to be related to intrusion of the Nipissing Diabase (Jambor, 1971b, c, d, f, g). An interesting local feature is the occurrence of cylindrical joints (Eakins, 1961).

Mafic and Ultramafic Dykes

Dykes unrelated to the Nipissing Diabase are abundant, and several ages are evident on the basis of crosscutting relationships. Some mafic and ultramafic dykes are restricted to the Archean greenstone belts, but lamprophyre dykes cut both Proterozoic and Archean rocks. Examples of

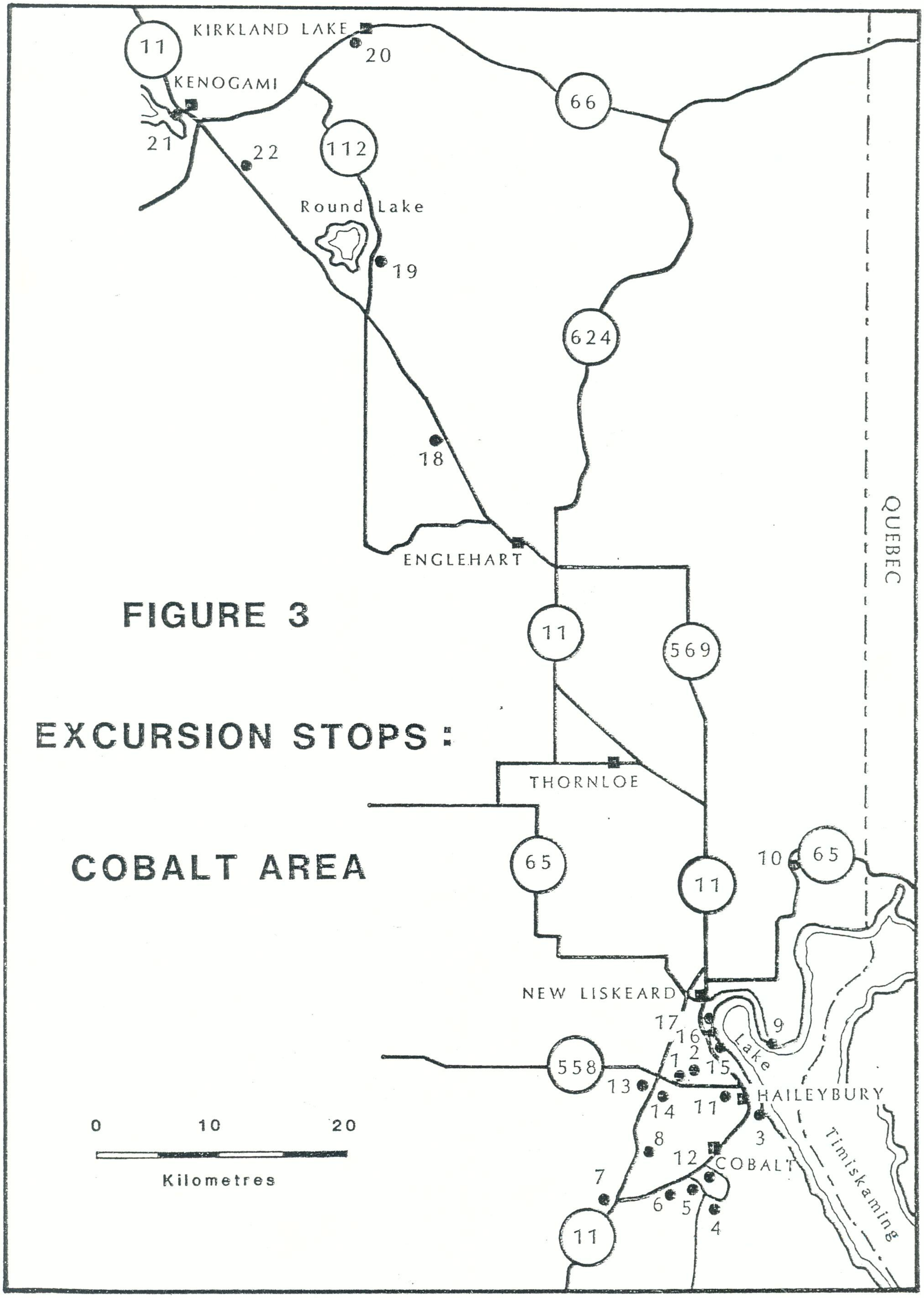
FIGURE 3
EXCURSION STOPS :
COBALT AREA
KIRKLAND LAKE
KENOGAMI
Round Lake
ENGLEHART
THORNLOE
NEW LISKEARD
HAILEYBURY
COBALT
Lake
Timiskaming
QUEBEC
11
66
112
624
569
65
558
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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21
22
0
10
20
Kilometres

DAY 2

STOP 1: GOWGANDA FORMATION (Road cut on north side of Highway 558, about 1.5 kilometres east of junction with Highway 11).

This stop (Fig. 4) provides an introduction to typical diamictites of the Coleman member (Gowganda Formation), lowermost unit of the Cobalt Group (Huronian Supergroup). Clasts composing the framework reflect the predominance of granitoid rocks in the Archean basement, but a wide variety of metavolcanic and metasedimentary source rocks (including clasts of Archean conglomerate) are also represented. Subhorizontal bedding is indicated by intercalated lithic sandstones (some showing faint crossbedding) and argillites (locally exhibiting varve-like graded couplets). Faults with minor displacement are abundant. Slickensides are prominent on some bedding-parallel faults, suggesting substantial telescoping, with concomitant repetition of stratigraphic units.

The diamictite framework components are dispersed in a matrix of mudstone, but some lenses of conglomerate are characterized by an arenaceous matrix, and show additional evidence of reworking, such as megaclast sorting or vague laminations within the matrix. The ranges of size, shape and roundness for the framework clasts should be noted for comparison with observations at Stop 4. Some fine-grained clasts are faceted and show surface striations.

STOP 2: PROTEROZOIC-ARCHEAN UNCONFORMITY (Outcrops 200-500 metres north of Highway 558, along unpaved road west of Dickson Creek).

Thick-bedded massive grey lithic arenites of the Timiskaming Formation (Archean) are here overlain by Coleman conglomerates (Fig. 5)

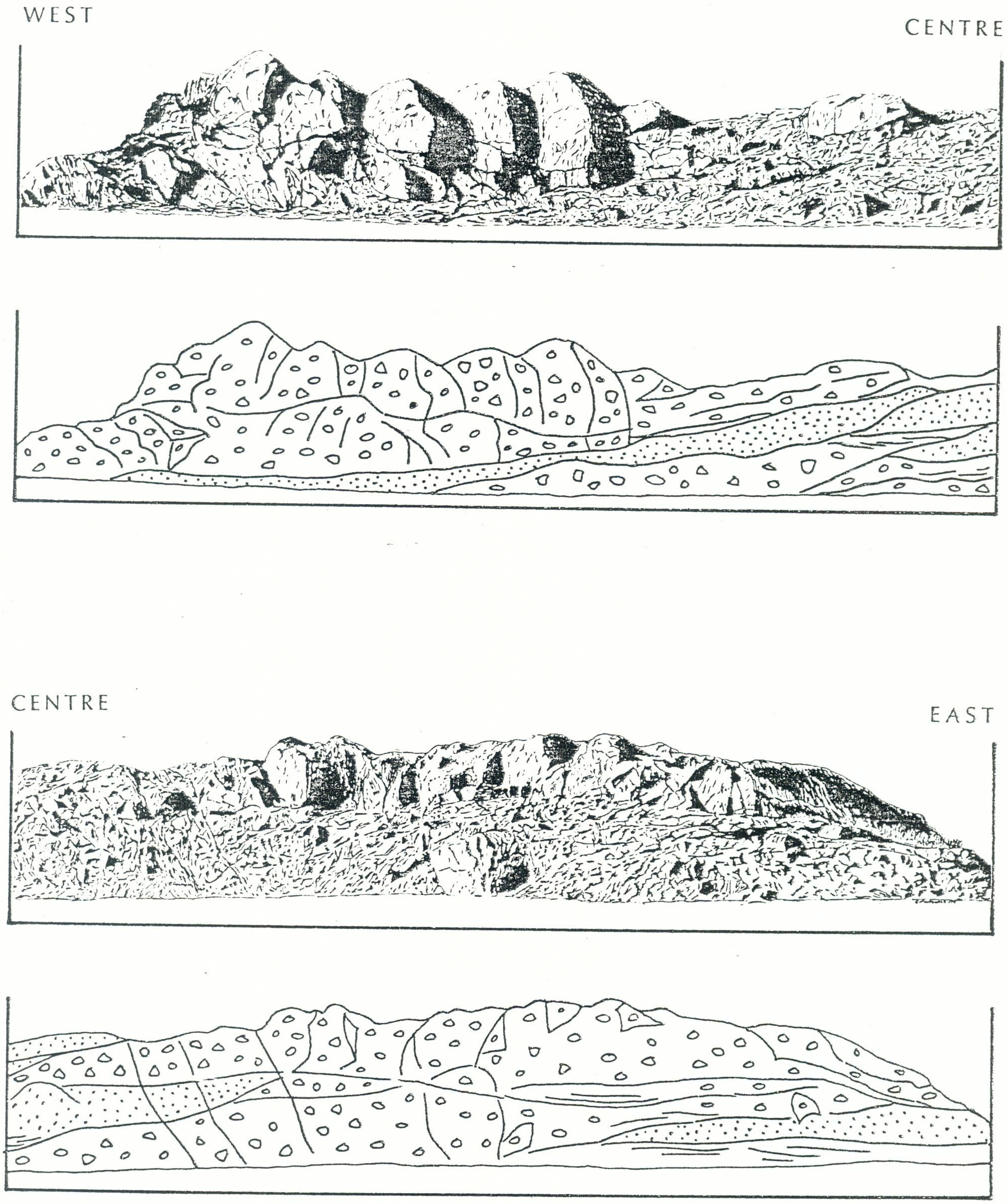

Figure 4. Sketches of west and east halves of outcrop at Stop 1, looking north. Schematic outlines beneath each half illustrate distribution of paraconglomerate (scattered-clast pattern), arenaceous interbeds (stippled) and lenses of argillite (parallel lines). Width of each view is 25 metres.

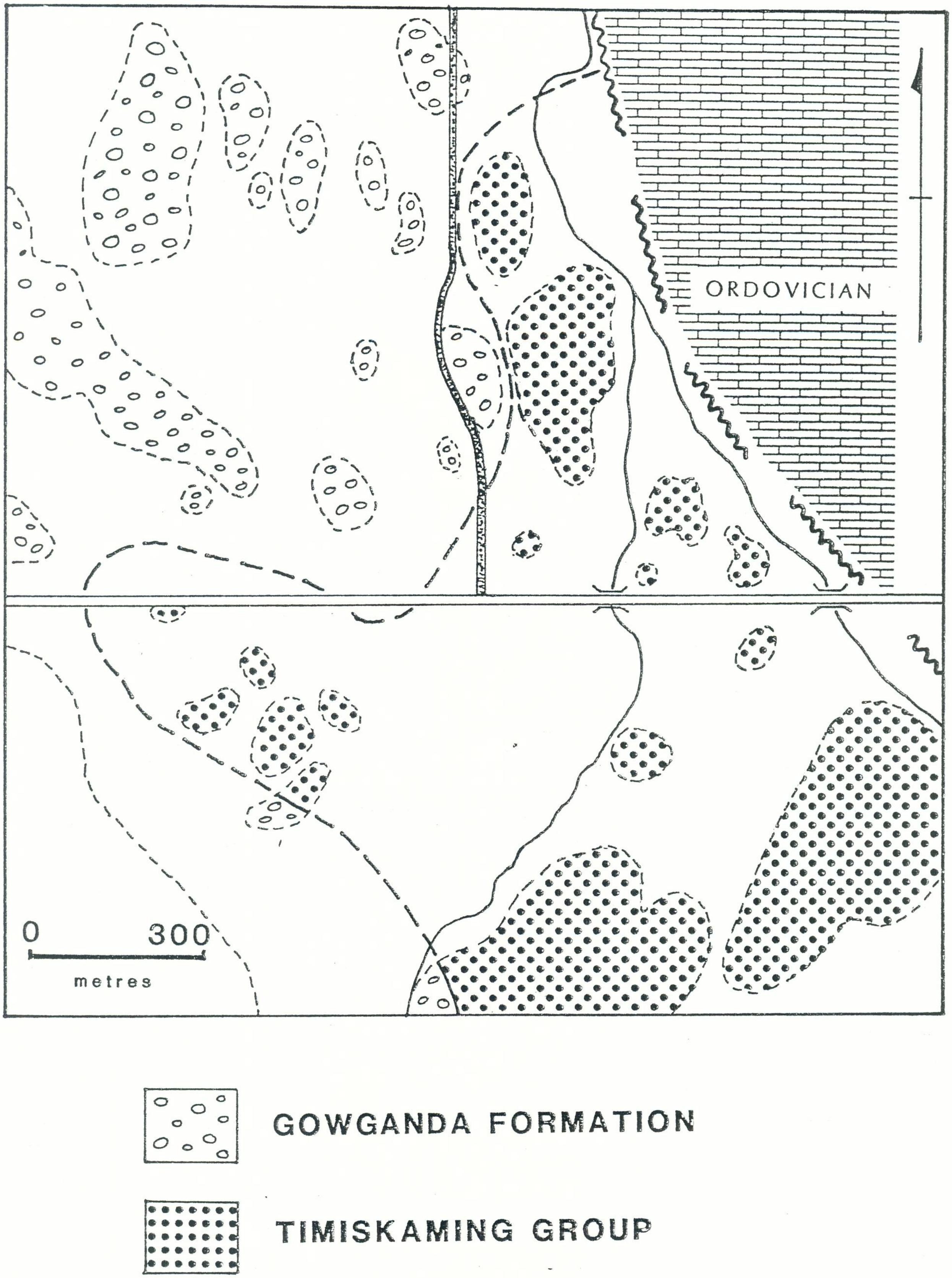

FIGURE 5. MAP OF UNCONFORMITY, STOP 2

similar to those seen at Stop 1. Bedding in the Archean sedimentary rocks trends northwest and dips steeply to the northeast. The unconformity surface is irregular, and in places is nearly vertical. Because the Cobalt strata have been only slightly folded, initial deposition of the Cobalt Group is inferred to have taken place on a rugged erosional surface on the Archean basement. This inference is supported by a regional study of paleotopography (Kim, 1979).

STOP 3: PILLOWED ARCHEAN METABASALT (Shore of Lake Timiskaming, one kilometer southeast of Lakeshore Hotel, Haileybury).

From the end of Elliot Street, walk southward a few tens of metres along the shore of Lake Timiskaming to a wave-washed exposure of typical pillow basalt. Most of the pillows have irregular to nebulous shapes, but a few display the characteristic form (Fig. 6) suitable for determining the facing direction (curved upper surface and pointed keel). Some also show cavities in the upper half, reflecting either the rise and coalescence of trapped gasses, or drainage of still-liquid lava. In mapping greenstone belts, differences in pillow size, pillow shape, selvage thickness, abundance and nature of amygdules, phenocrysts and variolites, cavity infills (quartz, carbonate, etc.), and presence or absence of hyaloclastite between pillows can prove useful in correlating and tracing individual flows. Bulbous budding from lava tubes can be seen near the north end of the outcrop (Fig. 7).

Sufficient three-dimensional views can be obtained at this outcrop to determine the attitude of this flow to be: 070°-80° SE; tops NW). Selvages here have a uniform thickness near 1.0 cm. Consisting now most of chlorite, the selvages represent original glassy chilled margins. Primary calcic plagioclase and pyroxene of the fine-grained pillow interiors have been metamorphosed to an assemblage of albite, actinolite, chlorite, epidote, magnetite and sphene.

STOP 4: GOWGANDA FORMATION (Outcrop on south side of unpaved extension of Coleman Road, 3 kilometres southeast of Cobalt).

This outcrop, about 400 m beyond the turnoff to the Hound Chute air compression station on the Montreal River, provides an excellent sampling of the Archean basement rocks, including Timiskaming conglomerate. Some of the larger clasts simulate "maps" of Archean terrane, revealing successive metamorphic events and intrusive relationships (Fig. 8). This outcrop also reveals the impressive size of some clasts in basal diamictites of the Coleman member. One boulder is greater than 1.5 m in diameter. This clast, as well as several others, have separated _in situ_ along internal fractures, allowing pre-lithification infilling by pebbly diamictite matrix (Figs. 9, 10). That such large clasts did not split during transport implies considerable coherence along the fractures before deposition. Post-depositional separation within the pebbly mudstone matrix can be explained as a response to repeated freeze-thaw action, a process that accounts for uniform separation along the infilled fractures.

The diamictite at this locality is overlain by thinly laminated argillites. These varve-like sediments are draped over clasts protruding from the upper surface of the diamicite, so that planar glaciated surfaces at the contact present views of concentric laminations around the clasts (Fig. 9). Relatively uniform thickness of the basal argillite beds where they warp over protruding clasts, suggests that the undulations were produced by post-depositional compaction.

Another interesting feature at this stop is the display of alteration rinds around some clasts in the diamictite. The rinds are readily explained as products of low-grade metamorphic reaction between clasts and matrix. However, some rinds only partially envelope clasts, and commonly clasts showing distinct reaction rims are adjacent to rind-free clasts of apparently indentical composition (Fig. 11). Kurt (1973, p.22) suggested that pre-depositional chemical weathering of some clasts would account for such anomalies. During transportation, the weathering rinds could be differentially abraded, thus allowing post-depositional reactions to occur preferentially around clasts that retained partial or complete rinds. An independent indication of pre-depositional chemical weathering is provided by a clast of Archean lithic sandstone cut by a lamprophyre dyke, in which distinct re-entrants at the margin of the clast correspond to the dyke (Fig. 12). Chemical rather than mechanical weathering best explains this relationship. The interpretation of glacial origin is supported by studies of the Gowganda Formation in numerous other localities (Casshyap, 1968, 1969; Lindsay et al, 1970; Lindsey, 1966, 1967, 1969, 1971; Ovenshine, 1964, 1965, 1970; Schenk, 1965).

STOP 5: GOWGANDA FORMATION (South of Coleman Road, 1.2 kilometres from junction with Highway 11B).

A cliff-section (Fig. 13) adjacent to the mined-out Little Silver Vein demonstrates extreme vertical uniformity and lateral continuity of laminated argillites in the Coleman member. Individual laminite beds, most less than 1 cm thick (Attitude: 010°-12°E), consist of distinct couplets of siltstone and claystone, which in turn are finely laminated. Near-symmetrical ripple marks with amplitudes up to 2.0 centimetres are abundant; bedding exposures reveal some interference patterns, but most show parallel linear crests; rare internal cross-laminations record both northward and southward transport (Fig. 14). The upward "memory" of the ripple forms is remarkable, persisting through hundreds of laminations. Possibly they record gentle action by waves at depth during storms, with early-established bed forms influencing subsequent sedimentation. Accentuation of the bedforms as a result of deformation seems unlikely, because crosslaminations are restricted to ripple crests.

Chlorite spotting, particularly abundant in the siltstone components of some couplets, has been attributed to low-grade contact metamorphism due to intrusion of the Nipissing diabase (Jambor, 1971e, noted that chlorite spotting in Gowganda sedimentary rocks is best developed within 100 m of contacts with diabase sills). The chlorite forms subspherical clusters commonly enveloped by bleached haloes, suggesting inward migration of iron and magnesium. Sulphide grains have acted as nuclei for some chlorite clusters, and where particularly abundant, the spots have coalesced to form distinctive markers.