WESTERN MARGIN OF THE LABRADOR TROUGH

by R.J. Wardle

INTRODUCTION

Approximately one month in the 1978 season was spent in a general reconnaissance of the western margin of the Trough in the Schefferville area for the purposes of comparison with areas of the central and eastern Trough mapped in previous years (Wardle, 1977; Wardle and Doherty, 1978). Emphasis during this work was placed on establishing stratigraphic relationships within the Knob Lake Group, in particular the existence and location of disconformities within the sequence.

The geology of the western margin is well known and most of the area has been intensively mapped at 1′ = 1000″, and more locally on 1′ = 200″, scale by Labrador Mining and Exploration Company (L.M.& E.) and the Iron Ore Company of Canada (I.O.C.C.). Geology on the accompanying map has been compiled from L.M. & E. and I.O.C.C. reports by Stocken (1949), Gilman (1950), and Perrault (1951) and from Geological Survey of Canada maps produced by Harrison *et al.* (1972). The area has been incorporated into the regional geological map of Frarey (1961).

The stratigraphy of the area has also been the object of several thesis studies (Howell, 1954; Perrault, 1955; Dufresne, 1952) and the iron formation the subject of a specialized study by Zajac (1974).

The western margin is largely semi-barren upland with topography dominated by steep northwest trending ridges. Exposure is generally excellent.

GENERAL GEOLOGY

The area is underlain practically entirely by the Aphebian rocks of the Knob Lake Group. To the west of the map area these lie unconformably upon the granulite facies Archean gneisses of the Superior Province, locally known as the Ashuanipi Complex. The only post-Aphebian rocks in the area are the Helikian dikes, informally known as the Mary Jo diabase.

In the axial region of the Trough the Knob Lake Group is a full, conformable succession which extends from the basal Seward Formation through to the Menihek Formation. In the western margin area, however, the Seward Formation is absent and the Knob Lake Group is interrupted by a disconformity at the base of the Wishart Formation. Progressing westward from the axial region of the Trough, this disconformity first appears west of the Knob Lake fault, where the Wishart Formation rests on the Fleming Formation, and becomes more pronounced towards the extreme western edge of the Trough (see palinspastic cross-section) where the Wishart Formation oversteps older Knob Lake Group rocks to rest directly on the Archean.

Attikamagen Formation - Unit 1

The Attikamagen Formation, estimated to be about 400 m thick, rests directly upon the basement. The contact, however, is not exposed. The unit generally consists of light gray-green shales interbedded with thin beds of cross-laminated, flaser bedded siltstone. Towards the top of the formation the sequence becomes interbedded with varicolored red and yellow shale and is eventually interbedded with dolomite at the contact with the Denault Formation.

Denault Formation - Unit 2

The Denault Formation comprises a well bedded sequence of dolarenites, dololuties and dolomite breccias that varies between 20 and 200 m thick. The brown weathering dolarenite beds which are 10-20 cm thick,

have well developed ripple bed forms, and are interbedded with similar sized units of massive or plane laminated, cream colored dololutite.

Towards the top of the formation the dolarenite beds frequently have massive graded lower portions which are scoured into underlying beds and grade up through cross-laminated and plane laminated divisions into dololutite. These rhythmically graded couplets are believed to have a turbidite origin. Interbedded in this sequence are rare units of graded chert sandstone which likewise appear to have a mass flow origin.

Dolomite breccias, ranging from 50 cm to several metres in thickness and composed of angular-subrounded slabs of bedded dolomite, occur throughout the Denault Formation. They are usually lenticular in shape, have a chaotic clast orientation and are channelled into the underlying beds. Clast diameters range between 5 cm and 1 m with larger clast sizes being present in the thicker breccia units. The origin of the breccias is not entirely clear but the most likely interpretation is that they are debris flows. Slump breccias composed of contorted dolomite beds and clasts are also present in the western parts of the formation and provide further evidence of sedimentation slope instability during Denault times.

The nature of the upper contact of the formation is highly variable. In the extreme east of the area the dolomite is conformably overlain by the Dolly Formation; in the central part of the area it is overlain both disconformably and conformably by the Fleming Formation; in the Evelyn Lake area it is disconformably overlain by Wishart Formation; and in the western part of the area it has a conformable contact with the Dolly Formation.

Dolly Formation - Unit 3

The Dolly Formation is present in two distinct basins in the western margin area (see cross-sections). The easternmost basin comprises a wedge shaped unit of shales and siltstones which thickens to the east to about 500 m, and has been recognized as extending under most of the axial region of the Trough (Wardle and Doherty, 1978). Only the westerly exposures of this basin are seen in the map area and consist of a sequence of fissile black shale overlain by banded red and green mudstone in turn overlain by gray shales and siltstones. To the east the basin is dominated by a monotonous sequence of gray shale and siltstone.

The westernmost basin comprises a thin lenticular unit of thinly bedded gray shale and siltstone approximately 180 m thick. These rocks are well exposed east of Stakit Lake, where they were previously mapped as Attikamagen Formation (Perrault, 1951). The stratigraphic position of the unit between the Denault and Wishart Formations, however, requires a correlation with the Dolly Formation.

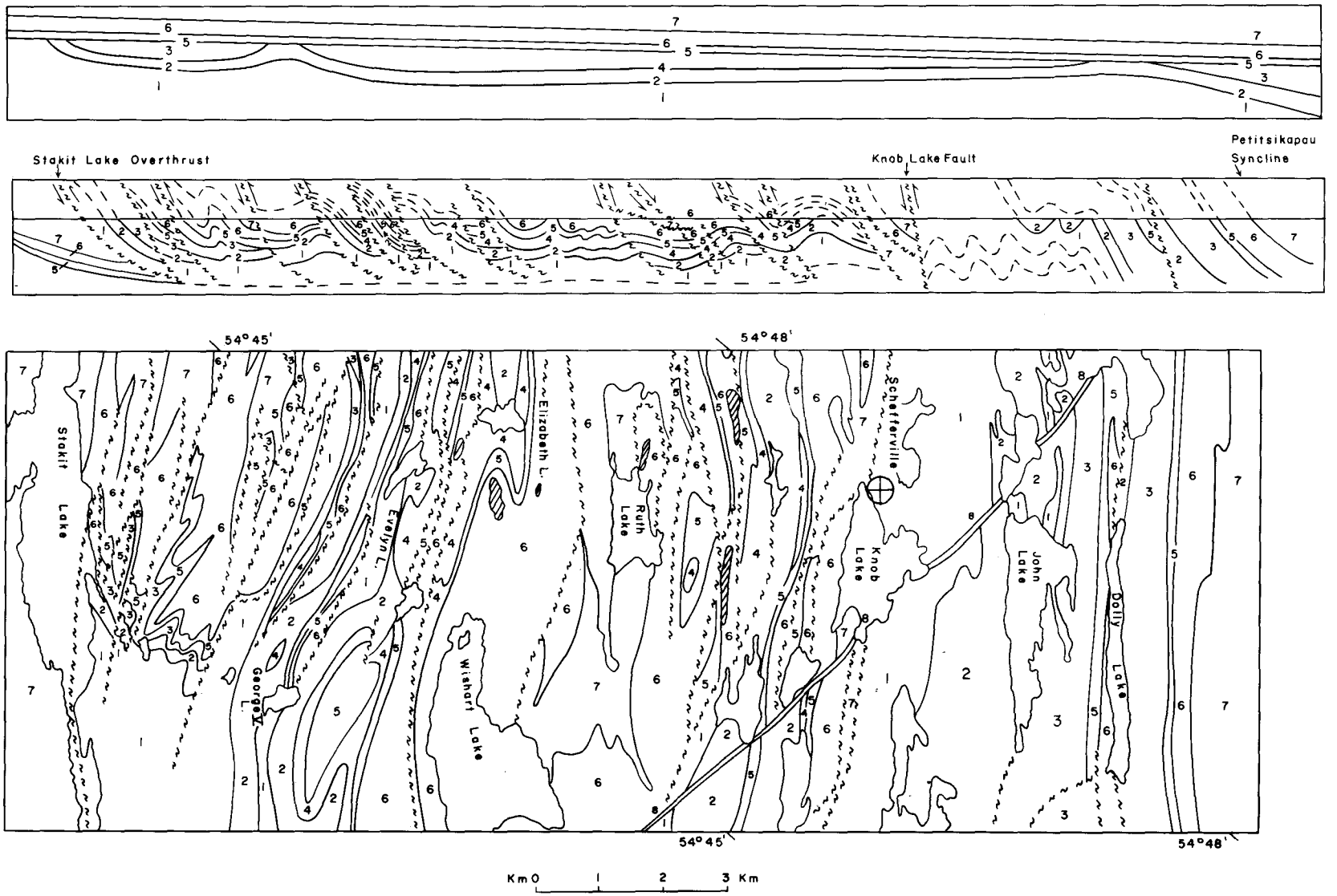
The Dolly Formation has a conformable contact with the underlying Denault Formation and is interbedded with the lower part of the overlying Wishart Formation.

Fleming Formaton - Unit 4

The Fleming Formation comprises a heterogeneous assemblage of massive and bedded chert breccia and quartzite which attains its greatest thickness (approximately 100 m; Harrison *et al.*, 1972) in the Ruth-Wishart Lake area and thins gradually to the east. In the east, near Knob Lake, the unit consists of a lower series of chert breccia beds overlain by a series of thinly laminated gray quartzites and cherts with occasional breccia interbeds. The lower breccia beds consist of highly rounded clasts of gray and black chert set in a structureless gray quartzite matrix. Highly contorted and broken chert beds are also present and it appears that the breccia structure developed during slumping or mass flow. The lower chert breccia beds are scoured into the underlying dolomite and locally incorporate disorientated blocks of bedded dolomite, indicating that the contact with the Denault Formation in this area is a disconformity.

In the west the Fleming Formation has a different aspect and consists almost entirely of a monotonous sequence of white, pink and gray chert breccia, with white and gray colloform banded clasts set in a fine quartzite matrix, in which bedding is only vaguely recognizable on a 1-2 m scale. Discreet beds, about 1 m thick and composed entirely of colloform banded chert, occur within the sequence but do not extend along strike for more than 20 m and may be megaclasts. The chert breccia in this area passes down into a thin unit (about 15 m thick) of yellow and green shales and mudstones which grade conformably down into the Denault Formation.

Various modes of origin for the Fleming Formation have been proposed by early workers, including (a) karstification of a subaerially exposed dolomite surface, (b) wave action on an interbedded chert-quartzite-dolomite sequence, and (c) slumping of a chert-quartzite sequence (see review by Dimroth, 1971, p. 1445). More viable subsequent studies by Howell (1954) and Dimroth (1971) have demonstrated that the chert in the breccia is largely secondary. Thus, it has been proposed that the protolith for the unit was an interbedded sequence of dolomite and quartz rich siltstone which was



WESTERN MARGIN OF THE LABRADOR TROUGH

LEGEND

NEOHELIKIAN

8 **Mary Jo Diabase:** *Diabase, microgabbro.*

APHEBIAN

Knob Lake Group

7 **Menihek Formation:** *Black shale and siltstone.*

6 **Sokoman Formation:** *Cherty iron formation (includes Ruth Formation black shales and cherts).*

5 **Wishart Formation:** *Quartzite, siltstone, granule conglomerate.*

4 **Fleming Formation:** *Chert breccia.*

3 **Dolly Formation:** *Gray shale and siltstone, minor black, red and yellow shale.*

2 **Denault Formation:** *Dolarenite, dololutite, dolomite, breccia.*

1 **Attikamagen Formation:** *Gray siltstone and shale.*

ARCHEAN

A **Ashuanipi Complex:** *Granite gneiss, granite.*

SYMBOLS

Iron deposits .....

Producing mine .....

Abandoned mine .....

Fault .....

Geological contact .....

subjected to dissolution, replacement by chert, and general silicification in the early stages of lithification.

As a result of work in 1978 it is believed that the subsequent brecciation resulted from slumping and mass flow down unstable basin slopes. In this respect it is significant that the breccias in the eastern part of the Fleming Formation are similar to those interpreted as debris flows in the underlying Denault Formation and also that the Fleming Formation was deposited in unstable conditions during a time of warping and uplift of the western margin of the Trough.

Wishart Formatin - Unit 5

This formation, estimated to vary between 30 m thick in the west and 60 m thick in the east (Harrison *et al.* 1972), consists predominantly of medium bedded, gray, feldspathic quartzites interbedded with variable amounts of siltstone, shale and white orthoquartzite. A highly characteristic feature of the Wishart Formation in the western margin area is the occurrence of beds of quartz-K feldspar granule conglomerate up to 2 m thick in the upper part of the formation. Cross-bedding and ripple marks are common throughout the section. The base of the formation is generally composed of siltstones and shales interbedded with thin chert-quartz pebble conglomerates. The Wishart Formation is interbedded with the Dolly Formation. Its contacts with the Denault, Fleming and Attikamagen Formations, however, are sharp and appear disconformable.

Sokoman Formation - Unit 6

As shown on the map this formation includes the black ferruginous shales and cherts of the Ruth Formation as well as the overlying cherty iron formation typical of the Sokoman Formation proper. The total thickness of the unit is 200 m, of which 20 m is the Ruth Formation.

The iron formation is usually subdivided into three members. The lower member consists of thinly bedded, plane laminated, orange-brown weathering silicate and silicate-carbonate cherty iron formation. The middle member comprises more thickly bedded, blue-gray, oxide iron formation with characteristic granular and oolitic textures; it is locally cross-bedded, and contains frequent lenses and nodules of diagenetic red jasper and chert. The upper member is composed of carbonate rich gray cherts, gray magnetite rich oxide iron formation, and lean gray cherts. In the eastern part of the area the upper and lower iron formations contain graded mafic tuff horizons which are distal equivalents of volcanics of the Nimish Subgroup (Zajac, 1974; Evans, 1978).

The Sokoman and Ruth Formations are conformable with the underlying Wishart Formation.

Menihek Formation - Unit 7

The basal 20-30 m of the formation comprises black pyritiferous shales which grade conformably into the Sokoman Formation. These are overlain by a sequence, at least 400 m thick, of interbedded black shales and feldspathic siltstones in which the siltstone units display all the characteristics of turbidite units, *i.e.* sharp. scoured basal contacts commonly associated with flute casts, graded bedding, and partial or complete Bouma sequences

Mary Jo diabase

The Knob Lake Group is cut by several en échelon, north trending dikes of diabase and microgabbro, collectively known as the Mary Jo diabase. They are fresh, olivine bearing rocks which are posttectonic and bear a close textural resemblance to gabbros of the Helikian Shabogamo Gabbro in the southern Trough (see Wardle, this volume). Leech *et al.* (1963) and Wanless *et al.* (1968) have determined K/Ar ages of 1255±52 Ma and 1146±104 Ma respectively on representatives of the unit.

Stratigraphic relationships within the Knob Lake Group

Either during or after deposition of the Denault Formation, the westen margin of the Trough was warped into a series of basins and uplifts. Deposition in the basinal areas was continuous and consisted of Dolly Formation shales in the west and east, and chert breccia of the Fleming Formation in the central basin (see palinspastic cross-section). Denault dolomite in the uplift areas around Knob Lake and immediately west of Evelyn Lake was lithified and partially eroded prior to deposition of the Wishart Formation.

The contact between the Denault and Fleming Formations is disconformable in the Knob Lake area but conformable further to the west. The only explanation of this relationship appears to be that the Denault Formation in the Knob Lake area was subaerially exposed and lithified during early Fleming Formation times, then subsided and became inundated by chert breccia during the late stages of deposition of the Fleming Formation.

The presence of debris flows and turbidites within the Denault Formation indicates that the formation accumulated as a slope facies on the edge of a carbonate shelf or bank. This shelf, which must have lain to the west of the present western limit of the Denault dolomites,

was presumably eroded during the period of warping and uplift in late Denault times.

The area stabilized towards the end of Dolly-Fleming times and was then covered by the Wishart transgression, which overlapped westwards onto the basement. Shallow water sedimentation continued through the remainder of the period of deposition of the Wishart and Sokoman Formations. The appearance of turbidites in the lower Menihek Formation, however, marks the end of stable shelf - shallow water conditions and the onset of deep water, basinal sedimentation.

STRUCTURE

The western margin is divisible into three structural zones; namely, the Stakit zone, the Schefferville zone, and the Petitsikapau zone (see cross-section). The Stakit zone, which is bounded in the west by the Wishart-basement unconformity and in the east by the Stakit Lake overthrust, is characterized by flat lying strata and a shallow, east dipping slaty cleavage. The Schefferville zone is bounded by the Stakit Lake overthrust and the Knob Lake fault and is characterized by shallowly plunging folds overturned to the west, and by closely spaced high angle thrust faults. The Petitsikapau zone is also characterized by shallowly plunging folds but lacks the overthrusting and closely spaced faulting which have produced the complex outcrop patterns typical of the Schefferville zone.

Harrison *et al.* (1972) have interpreted this variation in structural style to be largely controlled by the presence or absence of the Attikamagen Formation shales. In the Schefferville zone the competent clastics and cherts of the upper Knob Lake Group formations are separated from basement by the ductile shales of the Attikamagen Formation, which acted as a décollement zone and allowed folding and imbrication of overlying strata. The basement is also near the surface and has acted as a ramp for westerly directed tectonic transport. In the Stakit zone the clastics of the Wishart Formation rest directly on basement and, consequently, have not allowed any décollement. The Stakit Lake overthrust, which marks the boundary between the two zones, may have developed along the western edge of the Attikamagen Formation, where it terminated against the basement. In the Petitsikapau zone, however, the basement is probably present at greater depth, and Seward Formation clastics may be present below the Attikamagen Formation. Shales of the Attikamagen Formation have not been able to act as a décollement horizon and lateral shortening has been accommodated by folding and cleavage development rather than overthrusting.

ECONOMIC GEOLOGY

The area contains several large deposits of soft hematite ore which have been produced by leaching and secondary enrichment of iron formation during a period of Cretaceous weathering. The deposits have been more fully described by Harrison *et al.* (1972) and Gross (1968).

At present no nonferrous mineralization has been recorded in the western margin area. In Aphebian sequences elsewhere in the world, however, (*e.g.* West Australia, South Africa) disconformities and unconformities on the margins of sedimentary basins similar to the Trough are often the sites of fluorite and manganese mineralization. Such deposits are frequently located in chert breccias formed during karstification of dolomite unconformity surfaces. A similar potential may exist along the disconformities of the western margin of the Trough. However, the facts that the areas uplifted and actually eroded at any one time were small, and that the chert breccia is of submarine rather than Karst origin, tend to decrease this potential.

There may also be a potential for black shale and unconformity related uranium mineralization in the area.

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