STRATIGRAPHY OF THE STIKINE ASSEMBLAGE, SCUD RIVER AREA, NORTHWEST BRITISH COLUMBIA (104G/5, 6)

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INTRODUCTION

This is a preliminary report on the stratigraphy of the Late Paleozoic Stikine assemblage in the Scud River area of northwest British Columbia. Fieldwork was done in the summer of 1989 in conjunction with the Stikine Project (Brown and Greig, 1990, this volume). Relevant data collected last year for the Stikine Project (Brown and Gunning, 1989 a, b) is included. Additional fieldwork will be conducted next summer in conjunction with a graduate thesis.

The study area is near the confluence of the Scud and Stikine rivers in the rugged Coast Mountains (Figure 1-15-1). Strata examined occur in a northwest-trending belt exposed between the Scud River and Butterfly Lake. Fieldwork for the study was serviced from Telegraph Creek about 50 kilometres to the north.

The objective of this report is to provide detailed lithologic descriptions of the Stikine assemblage and to develop lithostratigraphic subdivisions in context with the structural setting of the sequence. It is based upon preliminary data from surface sections measured through Permian and "Permian or older" strata using hip chain, altimeter, Brunton compass and airphoto techniques.

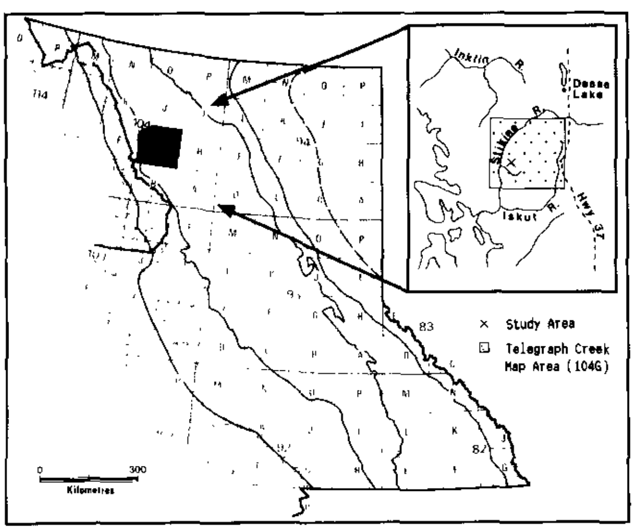

Figure 1-15-1. Location map for study area.

PREVIOUS WORK

The Stikine assemblage (Monger, 1977) refers to all Late Paleozoic rocks in northwest British Columbia which occur west of the Bowser basin and south of the Cache Creek Terrane. Rocks are Early to Middle Devonian to late Early Permian in age (Anderson, 1988). Thick successions of very fossiliferous Permian limestone characterize the assemblage and permit regional correlation between isolated and discontinuous exposures which occur along the western margin of the Stikine Terrane from Terrace to the Tulsequah River.

Regional mapping projects in the lower Stikine River region include the work of Dawson (1889), Kerr (1948) and Souther (1972). Several British Columbia Ministry of Energy, Mines and Petroleum Resources 1:50 000-scale mapping projects are in progress (Brown and Gunning, 1989, a,b; Brown and Greig, 1990, this volume; Logan and Koyanagi, 1989, a,b; Logan *et al.*, 1990, this volume). Detailed studies of the stratigraphy of the Stikine assemblage have been done by the Pan American Petroleum Company (Fitzgerald, 1960; Rigby, 1961), Monger (1970, 1977) and Holbek (1988). Paleontologic and paleostratigraphic studies have been completed by Pitcher (1960), Monger and Ross (1971), Mamet (1976), Rycerski (1985) and Stevens and Rycerski (1989). The work of Brown, Logan and their colleagues has greatly increased the paleontologic data base for the Stikine assemblage.

STRATIGRAPHY

Paleozoic strata in the Scud River area comprise four main subdivisions. From the bottom up, they are very deformed pervasively foliated dacitic tuffs and phyllites (Unit A) overlain by lower greenschist, intermediate to mafic volcanic flows and lesser crystal tuffs (Unit B). Thinly bedded sericitic dacitic lithic tuffs and siliceous siltstones (Unit C) conformably overlie the metavolcanic rocks and are in turn unconformably overlain by a thick Permian succession of fossiliferous limestone and subordinate varicoloured siliceous sedimentary rocks (Units D, E, F, G).

The age of Units A, B and C is unknown and the base of the assemblage is not exposed. At the toe of the Scud Glacier, the assemblage is conformably overlain by pyroxene-bearing greywackes of probable Late Triassic age.

The nature of the contact between Permian and "Permian or older" units varies but all contacts between units within the Permian succession are conformable. Lateral continuity of the units is also variable. True stratigraphic thickness is often indeterminate due to structural disruptions, rapid facies changes and inaccessibility of exposures.

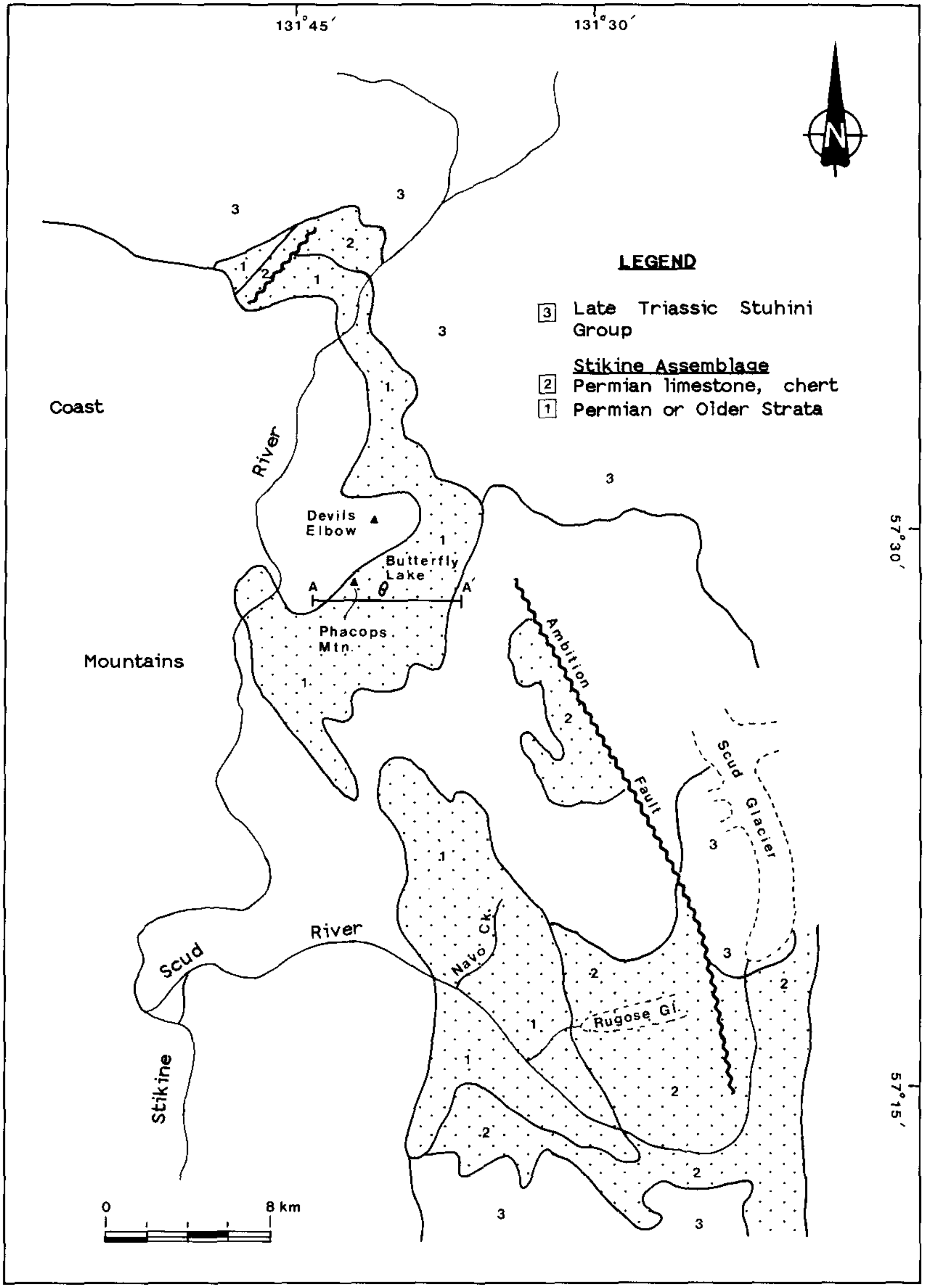

Figure 1-15-2. Simplified geology map showing the distribution of the Stikine assemblage in the Scud River area (modified from Brown and Gunning, 1989b).

Macrofauna and microfauna examined by E.W. Bamber of the Institute of Sedimentary and Petroleum Geology and M.J. Orchard of the Geological Survey of Canada in Vancouver respectively, indicate a probable Early Permian age (Artinskian) for the limestone succession although it could be as old as late Middle Pennsylvanian (Brown and Gunning, 1989b). There are no age constraints for strata which are structurally and probably stratigraphically below the Permian limestone.

PERMIAN OR OLDER STRATA

Rocks below known Permian strata are well exposed between Navo Creek and Butterfly Lake. They are north to northwest-trending metavolcanic rocks (Units A, B) conformably overlain by fine-grained siliceous tuffs (Unit C).

There is no area with continous, accessible exposures of all three units. Very deformed dacitic tuffs and phyllites of Unit A were examined west of Butterfly Lake. Variably chloritic andesitic flows with subordinate felsic tuffs and volcanic conglomerate of Unit B were examined east of Butterfly Lake (Basement Unit, Volcanic Facies; Brown and Gunning, 1989a, b). Well-bedded siliceous tuffs of Unit C were examined just north of Navo Creek where the underlying strata of pelites, foliated greywackes, and limy siliceous siltstones (Basement Unit, Sedimentary Facies; Brown and Gunning, 1989b) indicate there is a facies change within Unit B. The transition from dominantly volcanic to dominantly sedimentary rocks in Unit B may be about 2 kilometres north of Navo Creek where chloritic andesite flows and possibly sills are intercalated with foliated greywacke and argillite.

"Permian or older" metavolcanic and metasedimentary strata are continuous both north and south of the study area. Pelitic rocks north of Devils Elbow includes fossiliferous Mississippian(?) limestone (Kerr, 1948) and may be correlative with Unit B.

UNIT A

This unit is well exposed along the south flank of Phacops Mountain west of Butterfly Lake (Figure 1-15-1, 1-15-2) and consists of dacitic to rhyolitic lithic tuffs with subordinate intermediate to mafic flows. Relict bedding is generally overprinted by a parallel sericitic foliation. These rocks are more intensely deformed and more metamorphosed than those of Units B or C and may be the oldest in the region.

Poorly preserved load casts at one locality indicate stratigraphy is right-way-up. Beds strike to the southeast and dip steeply to the southwest. This orientation is consistent and strongly discordant to other "Permian or older" strata (Units B, C). Crenulation fabrics are common throughout this unit; vergence is variable.

The upper contact is obscured by a small, heterogeneous potassium feldspar megacrystic stock that crops out around Butterfly Lake. It intrudes Units A and B and is crosscut by a major north-striking vertical fault. The base of the unit is not exposed; it is intruded by a large body of middle Jurassic granodiorite southwest of Phacops Mountain.

Pale green sericite imparts a pervasive foliation throughout the unit. The degree of foliaton ranges from sericitic bedding planes to the formation of phyllites and sericite schists. Sericite content increases westward from Butterfly Lake at stratigraphically deeper levels.

Where preserved, bedding is defined by alternating bands of light and dark grey, fine-grained to aphanitic dacitic tuff less than 20 centimetres thick. White to pale grey weathering surfaces common in dacitic tuff beds in Units B and C are not present in this unit. Cloudy white felsic fragments and relict crystals are deformed. The fragments, up to 15 centimetres long, make up 10 to 15 percent of the rock and are commonly flat with depth to length to width ratios of up to 5:20:1.

A 3 to 4-metre bed of laminated siltstones and thinly bedded dacitic to rhyolitic lapilli tuffs is exposed about 1100 metres west of Butterfly Lake. The tuffs are deep green on fresh surfaces with well-developed pale green sericite on bedding planes. Bedding is defined by 15 to 25-centimetre zones made up of 60 to 80 per cent spherical to elliptical siliceous grains set in a milky white groundmass. Spherical grains are 1 to 3 millimetres in diameter; elliptical grains can be up to 15 millimetres long and are generally oriented parallel to bedding. The grains are cloudy grey and amorphous with a narrow (less than 2 millimetres) light grey rim. The rims may have formed during growth of the grains or they may be an alteration halo. Load casts and possible grading in the lapilli tuffs indicate that strata are right-way-up.

Variably chloritic, massive to poorly foliated dark green andesitic flows and possibly sills are intercalated throughout the dacitic tuffs but comprise much less than 1 per cent of the unit.

UNIT B

Unit B is well exposed east of Butterfly Lake and consists of variably chloritic intermediate to mafic volcanic flows with subordinate siliceous tuffs and volcanic conglomerate (Figures 1-15-2, 1-15-3). True stratigraphic thickness is uncertain because of structural shortening but the unit is less than 2500 metres thick.

The lower contact with Unit A is obscured by the Butterfly Lake alkalic stock. The upper contact with overlying siliceous tuffs of Unit C is conformable and gradational. The same contact relationship between Unit C and the sedimentary facies of this unit occurs just north of Navo Creek.

Attitudes of bedding and parallel chloritic and sericitic foliations are variable. Strikes vary within 20° of north. Dips vary from east to west and are generally less than 50° in the upper half of the sequence, and steep to vertical in the lower half. Correlative strata exposed both to the north and south of Butterfly Lake have a more consistent northwest strike and moderate to steep northeast dip. Load casts, flame structures, and graded bedding indicate that stratigraphy is right-way-up.

The unit consists mainly of massive to faintly foliated, hornblende and plagioclase-porphyritic to equigranular, fine-grained to aphanitic andesite to basalt flows. The flows are dark green on weathered and fresh surfaces. Chlorite content is variable but fracture surfaces are almost always chloritic. Phenocrysts are less than 15 per cent. Plagioclase is in cloudy white subhedral crystals less than 3 millimetres across. Euhedral, lath-shaped hornblende phenocrysts are up to 4 millimetres long. Traces of fine-grained biotite are also present.

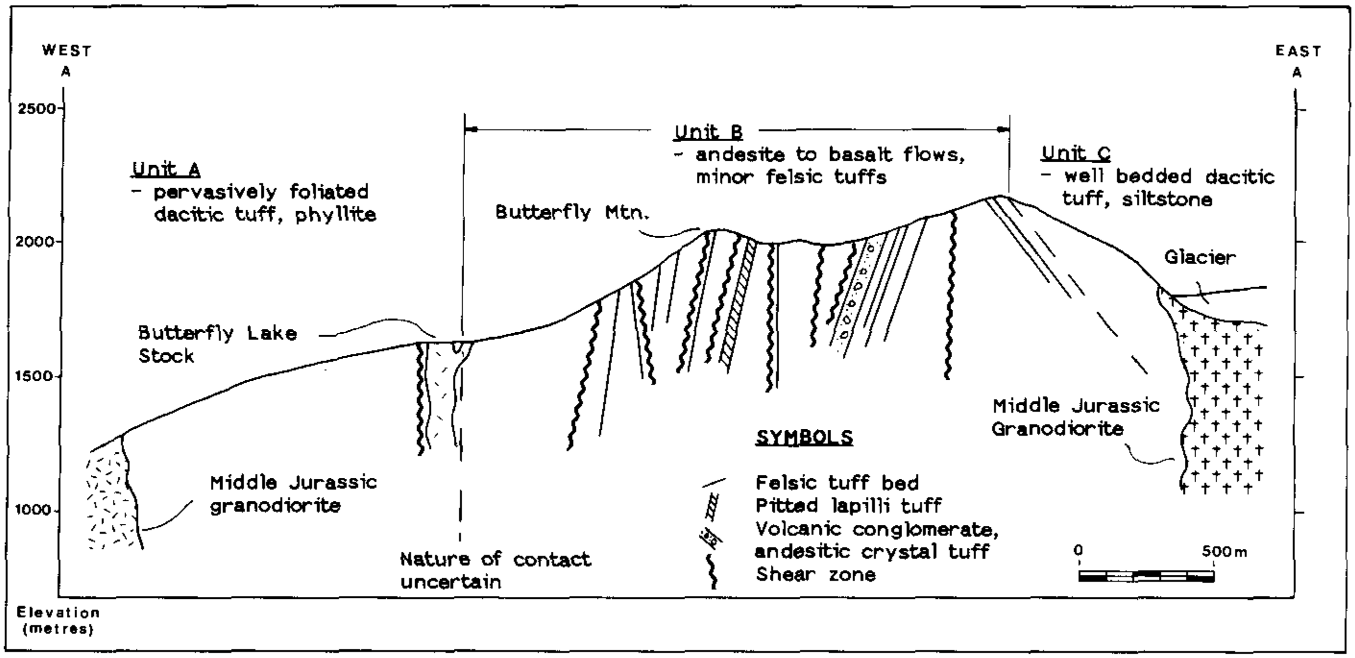

Figure 1-15-3. Schematic cross-section of "Permian or older" strata at Butterfly Lake.

Felsic crystal tuffs and volcanic conglomerates comprise about 10 per cent of the unit. There are at least 13 beds of fine-grained to aphanitic, pale grey to green, white-weathering siliceous (dacitic) tuffs in the unit. The tuffs are thinly bedded, well laminated, variably sericitic on bedding planes, and contain less than 5 per cent flat felsic fragments. The tuff beds are generally less than 2 metres thick and appear to accommodate much of the strain in the unit.

Approximately 2 kilometres east of Butterfly Lake, there is a zone 210 metres thick of interbedded andesitic crystal-lithic tuff and volcanic conglomerate within massive andesitic flows. The upper 70 metres consists of brown-weathering, pitted, limy lapilli tuff with 10 to 20 per cent subangular, fine-grained siliceous tuff fragments. Pitted textures are from weathered-out lapilli less than 5 centimetres across. The tuffs are interbedded with brown-weathering, matrix-supported monomictic volcanic conglomerate of similar composition. Clasts are well rounded, up to 40 centimetres across, and make up less than 40 per cent of the rock. The cobbles have not been deformed.

The lower 140 metres of this zone consists of white-weathering, andesitic feldspar-crystal tuff and polymictic volcanic conglomerate. The conglomerate is clast supported, made up of 70 to 90 per cent subangular cobbles. The matrix is aphanitic, dark grey and andesitic. Clasts are mainly light grey, fine-grained siliceous tuffs and lesser equigranular salt-and-pepper granodiorite and grey recrystallized limestone. Clasts average 5 to 10 centimetres across but can be up to 70 centimetres across. There are no known Paleozoic intrusions in the area.

This unit is tightly folded and cut by vertical shear zones. Fold axes plunge gently north with steep axial planes. Two fold cores were identified and eight more inferred from measurements of bedding and cleavage-bedding intersections. Nine zones of pervasive chlorite and sericite foliation are mapped and may be faults. The zones are generally less than 5 metres wide with gradational contacts; they commonly occur along siliceous tuff interbeds within massive andesitic flows where the tuffs grade into phyllites and the flows into chlorite schists. At least four of the zones appear to represent shearing along fold cores. Well-developed crenulation fabrics were observed adjacent to three of the structures with vergence variable from north to northwest to southwest.

UNIT C

This unit consists of fine-grained dacitic crystal-lithic tuffs (Siliceous Unit; Brown and Gunning, 1989a, b). It is well exposed north of Navo Creek (Figure 1-15-2) where it is approximately 1350 metres thick, although stratigraphic thickness varies greatly along strike. The unit is continuous through the study area, but like the Permian limestone, is absent north of Butterfly Lake where Late Triassic volcanic strata overlie "Permian or older" pelitic rocks. Continuity south of the Scud River is uncertain.

The section examined begins approximately 120 metres stratigraphically below the top of the unit. The tuffs are lithologically and texturally homogeneous and conformably overlie dark grey to black, well-foliated pelites and metagreywacke. The tuffs are well bedded, strike northwest and dip moderately to the northeast. Beds are well laminated, wavy, and generally less than 20 centimetres thick; pale green sericite is almost always present on bedding planes. Load casts and flame structures occur throughout and indicate strata are right-way-up.

The tuffs are white to dark grey or green on weathered surfaces. The lighter coloured tuff is generally very well laminated. It has less than 1 per cent poorly defined cloudy white lithic fragments less than 3 millimetres across, hosted in a light green to grey, amorphous, siliceous groundmass. Less than 1 per cent disseminated pyrite euhedra are present. The dark grey to green, more andesitic tuffs contain trace mafic crystals and 2 to 3 per cent cloudy white feldspar crystals and lithic fragments up to 3 millimetres across.

Black, well-laminated, amorphous siliceous siltstone beds occur throughout the unit and contain from 1 to 2 per cent disseminated pyrite. Thin, discontinuous layers of micrite and argillite comprise less than 1 per cent of the upper third of the unit. The beds are lensoidal, less than 20 centimetres thick, usually less than 50 metres long, and generally cleaved. The micrite is dark to light grey with no macrofossils.

PERMIAN STRATA

A thick succession of late Early Permian limestone and subordinate chert is well exposed between Rugose Glacier and the toe of the Scud Glacier (Figure 1-5-2). Four lithologically and faunally distinct units make up the sequence (Units D, E, F, G; Figure 1-15-4) and are described below from the base up. Limestone descriptions are according to Folk (1962).

The sequence is well bedded with north to northwest strikes and moderate to shallow east dips. Folds are open and plunge gently to the south and southeast. The sequence is over 2 kilometres thick although structural disruptions within the succession, in combination with rapid lateral facies changes and inaccessibility of some exposures, make determination of true stratigraphic thicknesses difficult. The contact between Permian and "Permian or older" strata varies from conformable (disconformity ?) to a 30° angular unconformity. It is structurally disrupted between Rugose Glacier and Navo Creek. The upper contact with Late Triassic volcanic and sedimentary rocks is conformable.

Ten kilometres to the north of Rugose Glacier, Late Triassic volcanic rocks overlie "Permian or older" metasedimentary rocks; the entire Permian limestone succession is absent. The limestone is more continuous to the south, exposed over 20 kilometres away in the Sphaler Creek area (Logan and Koyanagi, 1989a, b), and 50 kilometres to the south in the Iskut River district (Anderson, 1988).

UNIT D

This is a discontinuous, rusty weathering argillite that is best exposed at the toe of Rugose Glacier where it is approximately 85 metres thick. Thickness changes dramatically along strike and the argillite pinches out 2 kilometres south of the glacier. Continuity to the north is uncertain because of inaccessibility of exposures. The upper contact with Unit C is gradational.

The lower half of the unit is massive to well-laminated rusty weathering argillite with 2 to 10 per cent fine-grained pyrite and pyrrhotite occuring as disseminations and layer-parallel stringers. The upper strata have less pyrite and are more limy, grading into a black argillaceous micrite with rare solitary rugose corals up to 6 centimetres across.

UNIT E

This is the thickest unit in the Permian sequence. It is well exposed along the south side of Rugose Glacier where thinly bedded bioclastic limestone is over 1500 metres thick with no lithologic or paleontologic evidence for stratigraphic repetition. The same section of limestone exposed on the north side of the glacier is complexly folded with at least two layer-parallel structural disruptions. The unit appears to be folded inhomogeneously as only two small southwest-verging z-folds occur in the section examined.

The limestone is very fossiliferous and much of the paleontologic data for the Stikine assemblage comes from strata correlative with this unit. Fossil collections have been made from the base to the top of the section exposed at Rugose Glacier and there is no discernible age transgression.

The lower third of the unit (550 metres) is interbedded light and dark grey bioclastic micrite. The lower 30 metres of the unit is argillaceous and contains ubiquitous solitary rugose corals up to 5 centimetres across. Beds are generally planar and from 10 to 70 centimetres thick. The light grey biomicrite consists of up to 50 per cent white crinoid fragments and lesser bryozoa and other fossil debris. The fossil pieces are generally less than 7 millimetres across and are in a light grey micritic matrix with little sparry cement. The dark grey biomicrite is very bioclastic with up to 80 per cent branching and fenestrate bryozoa and well-preserved fusulinids. The fossils are both whole and fragmented and generally lie parallel to bedding in a dark grey to brown, fine-grained micritic matrix. Fenestrate bryozoa mats may be up to 15 centimetres long and 10 centimetres wide.

Approximately 200 metres from the base of the unit, there is a 3-metre bed of light grey biomicrite that contains abundant syringipora corals, large brachiopods, gastropods, branching bryozoa and fusulinids. About 350 metres from the base of Unit E, there is a bed of dark brown biomicrlutite over 30 metres thick that consists of over 70 per cent delicately preserved branching and fenestrate bryozoa, fusulinids, gastropods and ubiquitous large solitary horn corals up to 40 centimetres long that are commonly well exposed on weathered bedding planes.

The middle 700 metres of the unit is thinly bedded light grey biomicarenite and varicoloured amorphous chert. The chert is pale yellow and rarely black. It occurs as nodules and planar to wavy beds from 10 to 80 centimetres thick (Plate 1-15-1). The upper 100 metres of this section has less than 5 per cent chert beds and contains abundant solitary rugose corals. One 30-centimetre bed has 60 to 80 per cent small solitary rugose corals which generally lie parallel to bedding. There are also thin (less than 20 centimentres) beds of dark grey biomicrite composed almost entirely of layer-parallel, black, recrystallized, round to elliptical fusulinids and oblong bryozoa. The fusulinids are generally less than 1 centimetre long and the bryozoa can be up to 3 centimetres long.

The upper third of Unit E (510 metres) is thickly bedded grey to buff biomicrite and biosparite. Beds are 30 centimetres to greater than 1 metre thick and there are no chert beds.

About 400 metres from the top of the unit there is 30 to 40 metres of very bioclastic dark grey biomicrite that contains

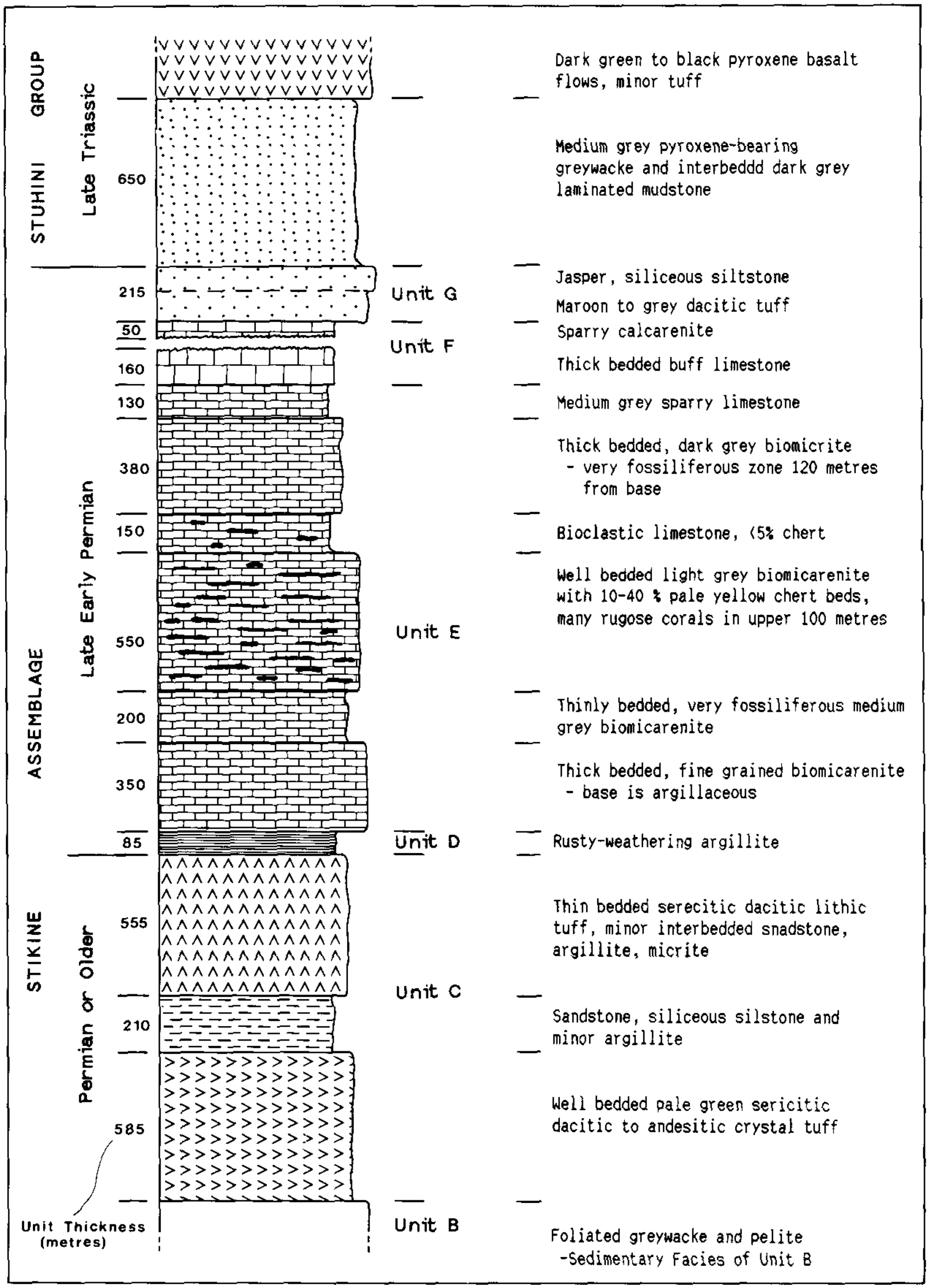

Figure 1-15-4. Schematic stratigraphic column of the Stikine assemblage in the Navo Creek, Rugose Glacier and Scud Glacier areas.

Plate 1-15-1. Bedded to nodular pale yellow chert within light grey biomicarenite in the mid-portion if Unit E.

abundant colonial corals and branching bryozoa up to 25 centimetres long. There are large solitary corals (*heritschioides* sp.) over 15 centimetres across and lesser fenestrate bryozoa, small rhynchonellid brachiopods, fusulinids and gastropods. Beds of dark grey biomicrite with fusulinids and branching bryozoa occur throughout the upper third of Unit E.

UNIT F

Unit F forms most of the peaks between Rugose and Scud glaciers. Stratigraphic thickness is uncertain due to structural disruption along the Ambition fault but the unit has a minimum thickness of 180 metres.

The lower part is mostly inaccessible and consists of massively bedded, white to buff-weathering sparry calcarenite with few macrofossils and no chert beds. The upper part is exposed on the east side of the Scud Glacier valley, east of the Ambition fault. It consists of approximately 50 metres of massively bedded buff to white-weathering sparry calcarenite with thin discontinous beds of argillite and maroon crystal-lithic lapilli tuff. The tuffs contain 7 to 10 per cent quartz and feldspar crystals, and less than 7 per cent black, subangular to flat lithic fragments less than 2 centimetres long. Some of the tuff beds appear to be structurally disrupted.

The upper 15 metres of Unit F is thinly bedded biocalcarenite and sparry calcarenite. The beds are 15 to 40 centimetres thick and load casts indicate that stratigraphy is right-way-up. The biocalcarenite beds have 60 to 70 per cent recyrstallized, white, elliptical to oblong fusulinids up to 3 centimetres long that are parallel to bedding. There are also small, poorly preserved solitary corals less than 4 centimetres across. Green to maroon crystal tuff and maroon tuffaceous micrite are interbedded with the biocalcarenite.

Conodonts from the fusulinid-rich limestone are Permian but have significantly different morphologies from those in the thick sequence of thinly bedded bioclastic micrite of Unit E (M.J. Orchard, personal communication, 1989).

UNIT G

Varicoloured siliceous sedimentary and volcanic rocks of Unit G comprise about 210 metres of strata well exposed east of the toe of the Scud Glacier. The lower contact with the tuffaceous limestone of Unit F is gradational. The unit is conformably overlain by pyroxene-bearing greywackes correlative with the Late Triassic Stuhini Group. Beds are right-way-up and strike northwest with moderate east dips. These rocks were previously mapped as Middle Triassic.

Fine-grained siliceous tuffs comprise the lower 130 metres of the unit. The tuffs are maroon to dull grey, fine grained to aphanitic, and massive to faintly foliated, with 5 to 15 per cent lithic fragments less than 5 millimetres across. Mafic crystals less than 3 millimetres across occur in the maroon tuffs. Exposures of the tuffs are generally rounded with poorly defined bedding. Orientation of the tuffaceous strata is commonly defined by rare interbeds of laminated, dark grey, very poorly sorted, coarse-grained volcanic greywacke.

Overlying the tuffaceous strata are 85 metres of fine-grained siliceous sedimentary rocks. The lower 15 metres consist of thinly bedded, wavy, pale green amorphous siliceous siltstone. Above the siltstone is a very distinctive horizon of bright red, thinly bedded radiolaria-bearing jasper. Beds are wavy, from 5 to 10 centimetres thick, and have dark grey mudstone lamellae. Thin interbeds of amorphous, green siliceous siltstone and black argillite comprise less than 5 per cent of the jasper sequence.

The jasper is overlain by rusty weathering, thin-bedded, pyritic green siliceous siltstone and a distinctive horizon of black ribbon chert. Permian conodonts were retrieved from the ribbon chert (M.J. Orchard, personal communication, 1989) which consists of 20 to 40-centimetre, black, amorphous chert beds separated by beds of graphitic argillite less than 10 centimetres thick. The upper 15 metres of Unit G is amorphous, thin-bedded green siliceous siltstone with less than 1 per cent disseminated pyrite. Well-laminated beds are wavy and from 1 to 30 centimetres thick.

LATE TRIASSIC STRATA

At the toe of the Scud Glacier, thin-bedded, well-laminated, dark to light grey mudstone, siltstone and greywacke conformably overlie the Permian siliceous sedimentary rocks. The beds contain many sedimentary structures including load casts, mudstone rip-ups, flame structures, graded bedding, and cut-and-fill channels which indicate stratigraphy is right-way-up. Narrow 1 to 2-metre zones of well-laminated, dark grey to brown mudstone and siltstone occur within much thicker zones of medium to light grey greywacke.

The thickness of this unit is about 650 metres; true stratigraphic thickness is uncertain because of cover by the Scud Glacier. On the west side of the glacier, the laminated greywacke grades upward into coarse-grained andesitic tuffs and polymictic volcanic breccia overlain by a tremendous thickness of dark green to black pyroxene basalt and minor intercalated maroon volcaniclastics. These rocks are correlative with the Upper Triassic Stuhini Group.

SUMMARY

Paleozoic strata in the Scud River area consist of a thick succession of late Lower Permian limestone and subordinate chert which unconformably overlies more deformed and more metamorphosed felsic to mafic volcanic rocks and metasedimentary strata. Exposures at the toe of the Scud Glacier suggest that the Upper Triassic Stuhini Group conformably overlies Permian strata of the Stikine assemblage. Developing a better understanding of the Permo-Triassic boundary, and of the nature of the pre-Permian unconformity, will be important aspects of this study.

There are seven distinct lithostratigraphic subdivisions which comprise over 4 kilometres of strata in the Scud River area. True stratigraphic thickness is difficult to determine, as is the lateral continuity of the various units; many of the units will not be useful for regional correlations. Continued fieldwork, in conjunction with a graduate thesis by the author, will further develop detailed lithologic descriptions and stratigraphic analyses. These data will be examined in context with the structural setting of the area to produce a better understanding of the paleoenvironment and tectonic evolution of the Stikine assemblage.

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