PRELIMINARY REPORT ON THE LILLOOET LAKE MAPPING PROJECT SOUTHWESTERN BRITISH COLUMBIA (92J/1, 2, 7)

By J.M. Riddell
University of Montana

KEYWORDS: Regional mapping, Lillooet Lake, Fire Lake Group, Cadwallader Group, stratigraphic correlations.

INTRODUCTION

Fieldwork conducted during the summer of 1989 covered a map area of approximately 200 square kilometres west of Lillooet Lake near Pemberton, southwestern British Columbia (Figure 1-4-1). This report discusses the observations of the first of two field seasons of a mapping project that will form the basis of a Master's thesis at University of Montana.

The area has been mapped as Triassic Cadwallader Group by Cairnes (1925), Roddick and Hutchison (1973) and Woodsworth (1977). Mapping by Journeay and Csontos (1989) indicates that the map area is transected by a north-northwest-striking structure, probably a thrust fault, with rocks of the Cretaceous Fire Lake Group lying to the west, and Triassic rocks, possibly of the Cadwallader Group, lying to the east. The purpose of this project is to map this area in detail, to study the nature of the contact between these two units, and to establish local and regional correlations with equivalent stratigraphic sections in the Coast Belt. This year's mapping has confirmed the existence of a major north-northwest-striking westerly directed thrust fault, and supports correlation of rocks to the west with the Fire Lake Group. Analyses of microfossil and radiometric samples collected east of the fault will help to determine whether these rocks are correctly correlated with the Cadwallader Group.

Further work will include petrology and structural analysis of oriented samples and field data. Fieldwork in 1990 will expand the map area north of Mount Currie and concentrate on improving the understanding of the Triassic stratigraphy east of the fault.

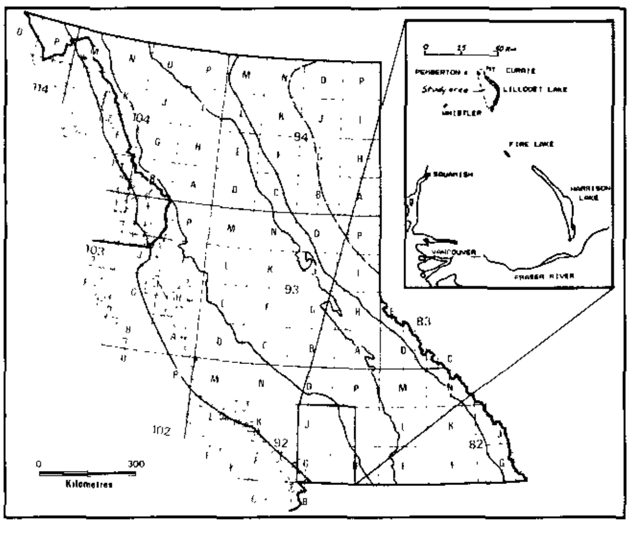

Figure 1-4-1: Location map.

TRIASSIC STRATIGRAPHY

Rocks to the east of the major thrust fault (main fault, Figure 1-4-2) are interpreted as Triassic, based on lithological similarities with rocks in the Tenquille Lake area which contain Norian microfossils (Woodsworth, 1977). No rocks from the study area have been dated.

Four major lithological units have been identified within this Triassic section. At this stage of the project contacts between these units are not well mapped and a good internal stratigraphy has not been developed. The following tentative stratigraphy is suggested and will be tested during the 1990 field season.

UNIT 1A (OLDEST): MASSIVE ANDESITE

Unit 1a is dominated by massive andesite and greenstone, and contains feldspar-porphyritic andesite, limestone pods and minor andesite breccias. Basalt is rare. The massive andesite is commonly speckled with rounded epidote clots and contains abundant epidote veins. Disseminated pyrite is ubiquitous. No pillow structures were seen. The unit is well exposed on the Lill property at the north end of Lillooet Lake (Figure 1-4-2), and along the Darcy road near Spetch, about 7 kilometres north of Mount Currie. This probably represents the base of the Triassic section. Mineral exploration in the map area has been concentrated within Unit 1a at the north end of Lillooet Lake. Brownish orange iron oxide staining can be seen in the cliffs above the lake, from the Duffy Lake road. Most of the mineralization that has been found is associated with skarn alteration of limestone pods by small hornblende diorite bodies, although mineralization associated with felsic fragmental rocks has been reported in the area (Day, 1987).

UNIT 1B: BANDED ANDESITE AND CHERT

A thickness of several hundred metres of banded andesite and chert is exposed at the north end of the easternmost ridge south of Ure Creek. The bedding strikes north-northwest and dips steeply to moderately to the west. The cherts are dominantly green, but locally white or black, and form beds 5 to 6 centimetres thick. Interbedded andesite is medium to dark green and massive, with bands centimetres to metres thick. Feldspar-porphyritic andesite was not seen in this section.

Unit 1c: Andesitic Fragmental Rocks

Unit 1c comprises a variety of andesitic fragmental rocks and greenstone. The fragmental rocks are consistently poorly sorted but show a wide variation in matrix type, clast type and clast size.

Feldspar crystal tuffs and lithic-lapilli tuffs with feldspar crystal tuff matrix are the dominant rock types at the south end of the easternmost ridge south of Ure Creek (Figure 1-4-2). Clasts are mainly white-weathering felsic volcanic fragments with lesser amounts of andesitic fragments. Green chert clasts are rare. Clasts make up anywhere from 0 to 80 per cent of the rock and average 3 to 4 centimetres in diameter.

The centre of the ridge is partly underlain by a hornblende and feldspar-phyric andesitic autobreccia; clasts average 5 or 6 centimetres in diameter and have deep purple reaction rinds. Distinct from this is another fragmental unit with an aphanitic, dark green andesitic matrix and a variety of clast types, including andesitic and felsic volcanic rocks, rare green or black chert, diorite, and basalt. Clast size in this breccia also averages 3 to 4 centimetres.

All of the andesitic fragmental rocks contain interbedded andesitic flows. Felsic flows are present but are not as common.

Unit 1d: Sedimentary Rocks

Sedimentary rocks are exposed on the west shore of Lillooet Lake, on the logging road that extends part way up the lake from the south. Black argillite and phyllite dominate the section, purple and green siltstones, volcanic sandstones and minor chert and limestone are also present.

The validity of the correlation of this Triassic section with the Cadwallader Group has been questioned because of the lithological differences between these rocks and the Cadwallader Group rocks described by Rusmore (1985) in the Eldorado Mountain area north of Gold Bridge, British Columbia. In contrast to the stratigraphy described above, the Eldorado Mountain section comprises a lower basaltic unit, a middle transitional unit and an upper sedimentary unit dominated by turbidites. It is interpreted to be an accumulation that formed adjacent to an active island arc (Rusmore, 1985). However, the lithological differences alone are not convincing evidence that the correlation is invalid. The rock types mapped east of the main fault in this study are also typical of those found in island arc assemblages. Because island arcs evolve and change rapidly, it is to be expected that abrupt lateral facies changes will occur within a single continuous arc (Hamilton, 1988).

CRETACEOUS STRATIGRAPHY

Unit 2a: Peninsula Formation

The lowermost unit seen west of the main fault is commonly well bedded and graded, and comprises interbedded quartz-bearing, white-weathering, feldspar-rich tuffaceous sandstone, siltstone, volcanic wacke and black shale. The section is topped by a pale-green-weathering tuffaceous sandstone that is conformable with the overlying breccia unit. Trough crossbeds are observed at this contact. Fossil and lithological similarities support correlation of these rocks with the Peninsula Formation as described by Arthur (1986). This unit has been mapped in the Fire Lake area by Lynch (in press).

This unit has several distinguishing characteristics. The white-weathering tuffaceous sandstones are quartz bearing and usually have a slightly calcareous matrix. Shaly beds are usually millimetres to centimetres thick and are a minor component of the section, but north of Ure Creek they can be tens of metres thick and make up a major proportion of the section. Plant fossils are often found in thin shaly beds in the tuffaceous sandstone. Shaly rip-up clasts are common (Plate 1-4-1). Rounded pebbles of feldspar-phyric volcanic rocks, coaly fragments and white to grey chert are found in pebble bands in the volcanic wacke. Brown-weathering, dark grey, massive limestone concretions 10 to 30 centimetres across are also found in the volcanic wacke (Plate 1-4-2). These concretions contain belemnites at one locality.

Unit 2b: Mauve and Green Andesitic Breccia, Brokenback Hill Formation

An andesitic unit, dominated by coarse autobreccia, conformably overlies the lowermost unit. This unit also contains pale green feldspar crystal tuffs and beige-weathering feld-

Plate 1-4-1: Shale rip-up clasts are common in the tuffaceous sandstone of Unit 2a (Peninsula Formation).

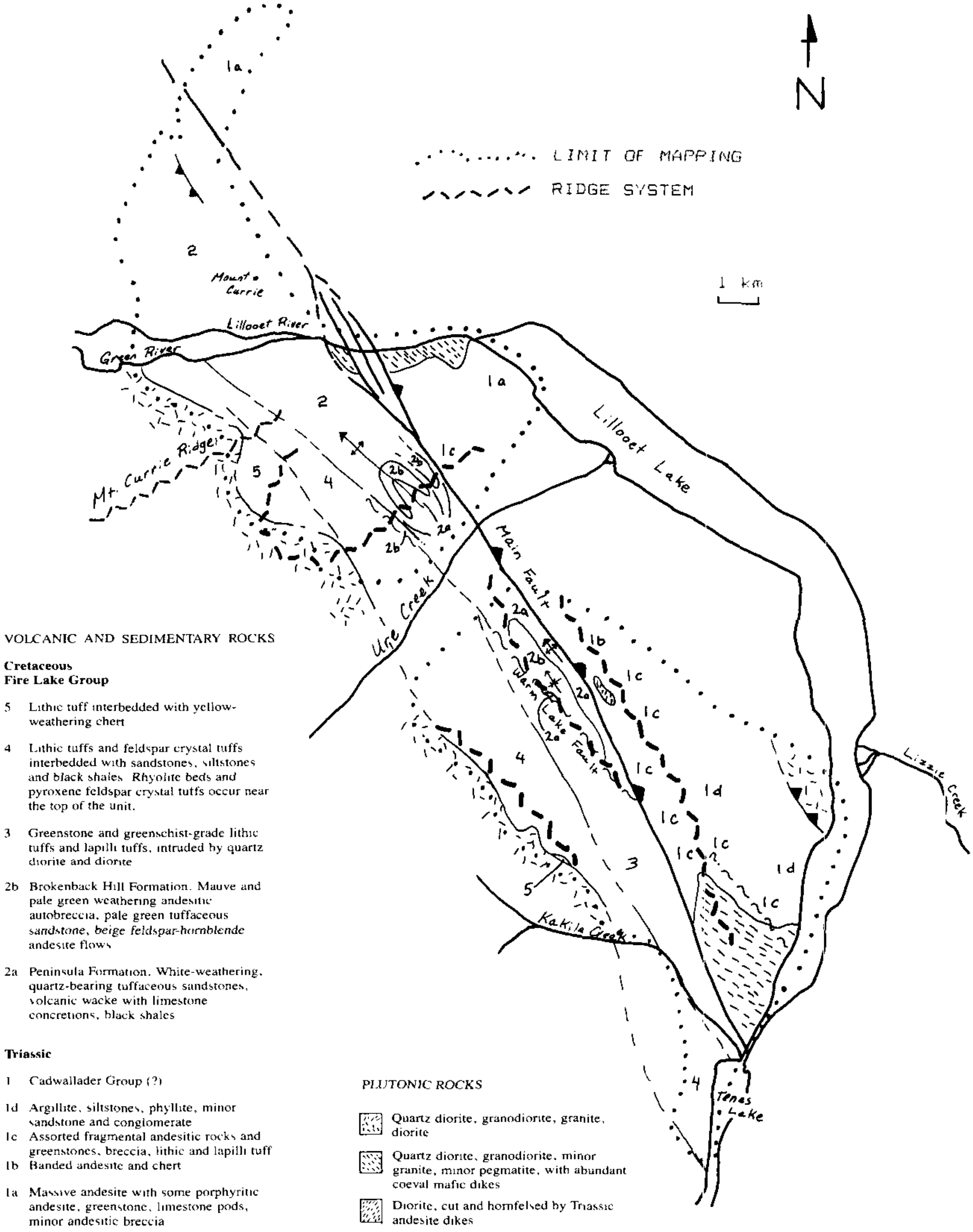

Figure 1-4-2: Geology west of Lillooet Lake.

Plate 1-4-2: Belemnite-bearing limestone concretions in volcanic wacke of Unit 2a (Peninsula Formation), north of Ure Creek.

Plate 1-4-3: Clasts in the mauve and pale green andesitic breccia of Unit 2b are commonly 3 to 6 centimetres in diameter, but are locally much larger, as seen in this photograph from south of Ure Creek.

spar and hornblende-phyric andesitic flows. It is correlative, on the basis of lithological similarity, to the Brokenback Hill Formation as described by Arthur (1986) and was mapped by Lynch (in press) in the Fire Lake area.

The breccia is marked by its distinctive pale pastel-green and mauve weathering colours. Breccia clasts are commonly 3 to 6 centimetres across, but are locally much larger. Clasts over a metre across are common south of Ure Creek (Plate 1-4-3). Clasts may be rounded with reaction rims, or angular with distinct edges. Angular and rounded clasts are seen together in some outcrops. Clasts are dominantly feldspar phyric and commonly contain hornblende phenocrysts. Jasper clasts occur locally in finer grained breccia (*i.e.* where clasts average 0.5 centimetre) and jasper less frequently occurs in interstices between large closely packed blocks. Clast-to-matrix ratios range from 80:20 to 30:70. The matrix is compositionally equivalent to the clasts, although hornblende phenocrysts are typically not as abundant in the matrix. This unit is very resistant and forms ridges and benches.

Unit 3: Greenstone

The Warm Lake fault (informal) separates Units 2a and 2b from the overlying Units 3 through 5.

The greenstone unit is exposed west of the main fault in the south half of the map area, north of Kakila Creek (Figure 1-4-2). It is cut off by the Warm Lake fault within the Fire Lake Group rocks and is not present north of Ure Creek. Unit 3 is composed primarily of greenstone and contains lapilli and lithic tuff units which are metamorphosed to greenschist facies by abundant quartz diorite and aplite dikes.

Unit 4: Interbedded Lithic Tuffs and Sedimentary Rocks

Unit 4 is well exposed west of Tenas Lake, in the saddle between the two westernmost ridges south of Ure Creek, and west of a deep saddle north of Ure Creek (Figure 1-4-2). The unit contains several indistinguishable lithic tuff units that are usually 20 to 30 metres thick, that contain feldspar-phyric volcanic and green siliceous clasts in a feldspar-crystal-rich matrix. These tuffs are interbedded with black shales, siltstones, tuffaceous sandstones and minor conglomerates. Near the top of the section, thin, frothy white rhyolite bands were seen. These are usually less than a metre thick. Pyroxene feldspar crystal tuffs are also common near the top of the section. The bands may be several metres thick and commonly contain euhedral pyroxene crystals up to 1 centimetre across. Black chert is present at the top of the section on the westernmost ridge. Thick quartz veins striking parallel to foliation are common in the sedimentary rocks.

UNIT 5: INTERBEDDED LITHIC TUFF AND YELLOW-WEATHERING CHERT.

This unit is well exposed only near the south end of the westernmost ridge in the map area and was found in float and rubbly outcrop on the ridge directly south of Mount Currie Ridge. The lithic tuff is similar to that found in Unit 4 but also contains angular purple and brown chert fragments. The yellow-weathering chert is pale grey on the fresh surface, with laminae that are often convoluted.

PLUTONIC ROCKS

The oldest plutonic rocks in the area are diorites which outcrop at the top of the easternmost ridge south of Ure Creek and predate the andesites there. The diorites are cut and hornfelsed by andesite dikes, and clasts of diorite are found in an andesitic breccia.

Quartz diorite, granodiorite and granite, and coeval mafic dikes are exposed near the north end of Lillooet Lake along the south shore of the Lillooet River, and at the south end of the lake. The age of these rocks is not known.

Strongly foliated quartz diorite is exposed on the west shore of Lillooet Lake, opposite the Lizzie Creek alluvial fan. Near the contact with Triassic sedimentary rocks to the south, the granitic rocks are mylonitized and contain northeast-side-up kinematic indicators. Mafic phases are metamorphosed to amphibolite grade. The sedimentary rocks south of the contact are unmetamorphosed. A northeast-side-up thrust fault relationship is inferred.

STRUCTURE

The dominant structural feature in the map area is the steep north-northeast striking thrust fault that places Triassic rocks to the east in contact with the Cretaceous Fire Lake Group rocks to the west. The fault zone is well exposed along the logging road that runs along the south bank of the Lillooet River. Kinematic indicators in this exposure consistently give an east-side-up sense of movement. The fault zone is marked by intense brittle deformation across a width of almost 2 kilometres at this location, and contains zones of sericite and talc schist, but is not as wide in the rest of the map area. The vast majority of outcrops in the map area exhibit moderate to intense, steeply-dipping north-northwest foliation fabrics.

Structures on the east side of the main fault are not well understood. In the relatively rare bedded rocks in the Triassic section, bedding and foliation orientations are parallel, indicating that at least some of the section has undergone high shear strain or isoclinal folding.

West of the main fault the Fire Lake Group rocks display well-developed bedding/cleavage relationships (Plate 1-4-4). North of Ure Creek, rocks are deformed into broad, open upright folds with near-horizontal fold axes which parallel the strike of the fault. This pattern is consistent with the east-side-up thrust direction indicated in the north road fault-zone exposure.

Deformation prior to the folding associated with the main fault is apparent in the Fire Lake rocks. A north-northwest-striking fault, the Warm Lake fault (informal), cuts out an unknown amount of section. Pre-existing folding is apparent south of Ure Creek where the overprint of the main fault folding event has produced a more complex interference pattern.

Late stage north-striking extension cracks are common throughout the map area, forming 1 to 10 metre wide chasms and rubble pits.

Plate 1-4-4: Well developed bedding/cleavage relationships displayed in a hinge zone in the volcanic wacke of Unit 2a (Peninsula Formation), north of Ure Creek.

ACKNOWLEDGMENTS

This project is supported by the Geological Survey of Canada (Pemberton Project), and by funding from Geoscience Research Grant Number RG89-24 from the British Columbia Ministry of Energy, Mines and Petroleum Resources. I am most grateful to Murray Journeay for suggesting the project and for providing encouragement and excellent leadership during the field season. Field assistants Robin Shropshire, Laurie Welsh, Shelley Higman and David Bilenduke worked hard and provided moral support. Greg Lynch provided an introduction to the Fire Lake Group stratigraphy. I am grateful to John and Patricia Goats of Pemberton Helicopters for safe and dependable transportation and expediting.

REFERENCES

Arthur, A.J. (1986): Stratigraphy along the West Side of Harrison Lake, Southwestern British Columbia; *in* Current Research, Part B, *Geological Survey of Canada* Paper 86-1B, pages 715-720.

Day, W.C. (1987): Report on the Lill Property. Geochemical Survey for Greenlake Resources Inc.; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 15838.

Cairnes, C.E. (1925): Pemberton Area, Lillooet District, British Columbia; *in* Summary Report 1924, Part A, *Geological Survey of Canada*, pages 76-99.

Hamilton, W.B. (1988): Plate Tectonics and Island Arcs; *Geological Society of America Bulletin*, Volume 100, pages 1503-1527.

Journeay, J.M. and Csontos, L. (1989): Preliminary Report on the Structural Setting along the Southeast Flank of the Coast Belt, British Columbia; *in* Current Research, Part E, *Geological Survey of Canada*, Paper 89-1E, pages 177-187.

Lynch, J.G. (in press): Geology of the Fire Lake Group, Southeast Coast Mountains, British Columbia; *in* Current Research *Geological Survey of Canada*.

Roddick, J.A. and Hutchison, W.W. (1973): Pemberton (East Half) Map Area, British Columbia; *Geological Survey of Canada*, Paper, 73-17, 21 pages.

Rusmore, M.E. (1985): Geology and Tectonic Significance of the Upper Triassic Cadwallader Group and its Bounding Faults, Southwest British Columbia; unpublished Ph.D. dissertation, *University of Washington*, 174 pages.

Woodsworth, G.J. (1977): Pemberton (92J) Map Area, British Columbia; *Geological Survey of Canada*, Open File 482.