GEOLOGIC AND ISOTOPIC ANALYSIS OF THE NISLING – NORTHERN STIKINE TERRANE BOUNDARY NEAR ATLIN, BRITISH COLUMBIA (104M/8)

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INTRODUCTION

Three tectonic assemblages underlie the eastern flank of the Coast Range batholith in northern British Columbia: from west to east, the Nisling, northern Stikine and northern Cache Creek terranes (Figure 1-17-1). Each assemblage preserves a unique stratigraphy and geologic history, and the boundaries between these assemblages are marked by faults along much of their lengths. One of the goals for understanding the accretionary history of western North America is to document the time at which adjacent crustal fragments first came together. This study examines the age of juxtaposition of the Nisling and northern Stikine assemblages, and is part of a larger project focused on assessing the early Mesozoic tectonic relationships between the Nisling, northern Stikine and northern Cache Creek terranes.

The Nisling Terrane comprises metamorphosed sedimentary and volcanic rocks interpreted to belong to a Proterozoic to Paleozoic pericratonal basinal assemblage (Wheeler and McFeely, 1987). Nisling rocks lie west of volcanic and sedimentary strata of the Upper Triassic Stuhini Group, part of the northern Stikine Terrane. In northern British Columbia and southern Yukon, these two assemblages are separated by the north-northwest-striking Llewellyn fault zone (Bultman, 1979; Mihalynuk and Rouse, 1988; Mihalynuk *et al.*, 1989) and Tally Ho shear zone (Doherty and Hart, 1988; Hart and Pelletier, 1989; see Figure 1-17-1).

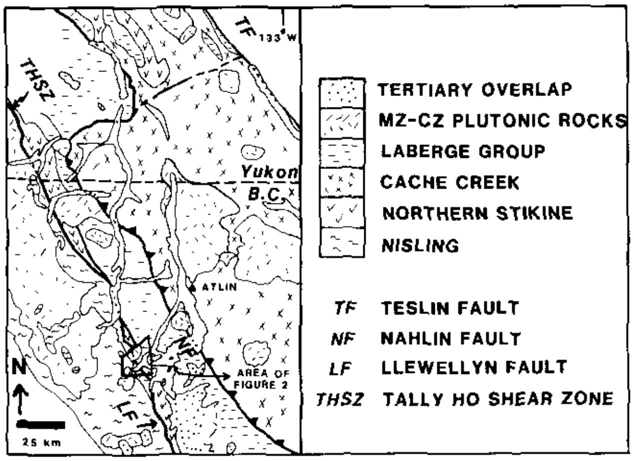

Figure 1-17-1. Generalized geology of the area around Atlin, British Columbia (modified after Wheeler and McFeely, 1987). Refer to the text for discussion of map units and structures. Note location of the Willison Bay study area.

Although northern Stikine lithologies are nowhere preserved in demonstrable primary depositional contact with Nisling rocks, several authors have discussed evidence pointing toward a Late Triassic link. Bultman (1979) noted: (1) the presence within Stuhini conglomerates of metamorphic clasts that resemble Nisling lithologies and of porphyritic granodiorite clasts that resemble a Late Triassic plutonic suite that intrudes Nisling rocks; (2) the presence within Nisling rocks of augite porphyry dikes that are similar to augite porphyry flows within the Stuhini succession; and (3) a zone of weathering, interpreted to be pre-Stuhini, within the porphyritic granodiorite near its contact with Stuhini strata. Werner (1978) also discussed the possibility of an original unconformity separating Nisling and Stuhini rocks, on the basis of similar chemical composition of pyroxenes in Stikine augite porphyry flows and in an augite porphyry dike that intrudes the Nisling assemblage. Mihalynuk and Rouse (1988) believe that an unconformity may be preserved in the Tutshi Lake map area (104M/15) due to a lack of deformational features within strata adjacent to the contact.

The goal of this research project is to evaluate geologic relationships noted previously along the Nisling-Stuhini contact, and to provide more quantitative constraints on the nature of the contact through analysis of the neodymium and strontium isotopic signatures of rocks near the contact. We chose to begin the study in Willison Bay at the south end of Atlin Lake (104M/8) where excellent exposures of Nisling and Stuhini rocks are preserved. In this report, we first describe the geology of the Willison Bay area, then discuss the isotopic studies in progress at the University of Arizona.

GEOLOGY OF THE WILLISON BAY AREA

Figure 1-17-2 shows a geologic map of the Willison Bay shoreline, illustrating the major rock units found along the Nisling-northern Stikine contact. General descriptions of these rocks are given below, as are relevant structural observations and interpretations of relationships between units. All descriptions are based on field observations only, as thin section analysis and quantitative petrography are in progress. This geologic framework was assembled as a basis for collecting and interpreting isotopic samples. For a more detailed account of the geology of the region, the reader is referred to Mihalynuk and Mountjoy. (1990, this volume).

LAYERED ROCKS

NISLING ASSEMBLAGE (PPZn)

The western end of the study area is underlain by Nisling assemblage rocks composed of biotite-quartz-feldspar

GEOLOGY OF THE WILLISON BAY AREA (104M/8)

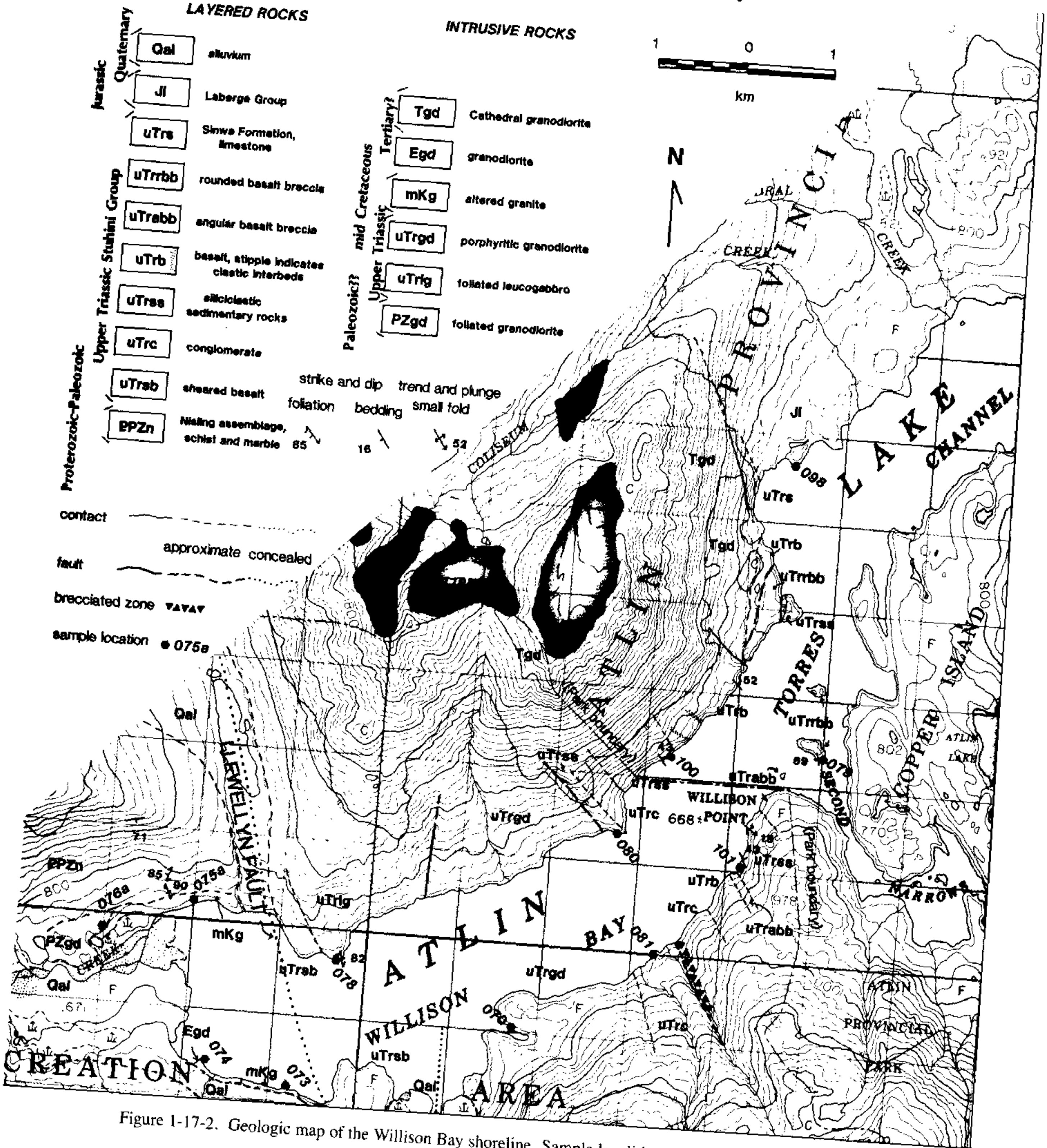

Figure 1-17-2. Geologic map of the Willison Bay shoreline. Sample localities are listed in Table 1-17-1.

schist, and marble units ranging from coarsely crystalline, white calcite marble to light grey, fine-grained well-foliated marble. Quartzofeldspathic schist grades into calcsilicate schist near contacts with the marble layers. Folding is apparent at outcrop scale and Mihalynuk *et al.* (1989) have interpreted at least four phases of deformation within the Nisling assemblage. Nisling rocks are intruded by the foliated granodiorite (PZgd) and the undeformed mid-Cretaceous granite (mKg) and Eocene(?) granodiorite (Egd). The Llewellyn fault forms the eastern extent of Nisling exposures.

UPPER TRIASSIC STUHINI GROUP

SHEARED BASALT (uTrsb)

Just east of the Llewellyn fault zone, the lowermost Stuhini unit consists of medium to dark green massive basalt and pyroxene-phyric basalt that have been strongly sheared, brecciated and locally altered by calcite veining. The fabric in these rocks is not penetrative, nor does it have a strong preferred planar orientation. Most of the brittle shear surfaces are, however, subvertical. Aside from the deformation and alteration, this unit resembles other Upper Triassic basalt layers along Willison Bay. The foliated leucogabbro (uTrlg) described below intrudes the eastern margin of this package.

CONGLOMERATE (uTrc)

A poorly sorted, matrix-supported, cobble to boulder conglomerate overlies the Late Triassic granodiorite (uTrgd). Alluvium conceals the contact along the shoreline, but higher on the slopes of the Cathedral (south of Coliseum Glacier, Figure 1-17-2) Mihalynuk (personal communication, 1989) has documented an unconformity preserved beneath the conglomerates. Clasts in the conglomerate consist mainly of felsic intrusive rocks, dominated by a porphyritic granodiorite identical to the underlying lithology. Locally, up to 5 per cent of the clasts are crenulated chlorite-quartz schists that resemble some lithologies in the Nisling assemblage. Other clast lithologies include intermediate to mafic volcanic rocks, argillite and minor limestone. All clasts, except the argillite fragments, are extremely well rounded, regardless of size. They are supported by a matrix of fine to medium-grained, dark green volcanic lithic arkose similar to the overlying sandstone. The siliciclastic strata (uTrss) conformably overlie this conglomerate.

SILICICLASTIC STRATA (uTrss)

This unit contains a variety of lithologies. On the north side of the bay, the dominant rock type is a green, pebbly to fine-grained, graded, volcanic lithic arkosic sandstone in beds from 50 to 200 centimetres thick. Most of the sandstone layers are slightly calcareous. Along the south shoreline, medium grey, calcareous greywacke, siltstone, argillite and mudstone characterize this unit, and the latter locally contains up to 1 per cent pyrite. These rocks contain abundant evidence of soft-sediment deformation, including contorted beds, small folds, rip-up clasts of sandstone within argillite, and dewatering structures. Coarse to medium-grained sandstone, similar to that along the north shore, are also interbedded with this sequence. Rare intraformational isoclinal folds plunge gently southeast and indicate deformation in the sedimentary rocks along the south shore (Figure 1-17-2).

BASALT (uTrb)

Along the south shore, Stuhini basalt is predominantly massive, medium green in color (due to low-grade metamorphism?) and contains small (<1 millimetre) veinlets of calcite. Along the north shore, a prominent, well-exposed section contains relict pillows about 70 centimetres in average length and 30 centimetres in average height. Zones with demonstrable pillows typically display pronounced carbonate coatings and minor calcite veining. Within this section are interbedded grey siltstone and fine-grained sandstone beds that have a platy character and weather to a brown colour.

ANGULAR BASALT BRECCIA (uTrabb)

Pyroxene porphyry basalt is found locally as monolithologic angular blocks within a basaltic matrix. Breccia blocks range in size from several centimetres to 50 centimetres in diameter. These deposits are poorly sorted in general, and contain rare quartz ± epidote veins that strike northwest, dip moderately northeast and display minor folds.

ROUNDED BASALT BRECCIA (uTrrbb)

Rounded fragments (bombs?) of pyroxene-phyric basalt up to 1 metre in diameter in a fragmental basaltic matrix comprise this unique lithology. Mihalynuk *et al.* (1989; unpublished field guide) interpret this unit as a phreatomagmatic breccia erupted in a shallow submarine setting.

SINWA FORMATION (uTrs)

Bultman (1979) correlated Norian limestone at the top of the Stuhini Group with the Sinwa Formation in the Tulsequah (104K) map area (Souther, 1971). Along the north shore of Willison Bay, Sinwa rocks consist of light to dark grey, well-layered, steeply dipping limestone and interlayered brown-weathering argillite sequences up to 30 metres thick.

LOWER TO MIDDLE JURASSIC LABERGE GROUP (Jl)

Laberge Group strata gradationally overlie the Stuhini Group and consist of interbedded argillite, siltstone and greywacke that are deformed into open, and locally tight to isoclinal, northwest-trending folds. Where sampled along the north shore of Willison Bay, Laberge rocks are dark grey platy, homogeneous siltstone and argillite that weather to a light brown colour.

INTRUSIVE ROCKS

FOLIATED GRANODIORITE (PZgd)

At the northwest corner of Willison Bay, a well-foliated, coarse-grained hornblendebiotite granodiorite intrudes the Nisling assemblage and is in turn intruded by the mid-Cretaceous granite (mKg). The degree of fabric development in this rock suggests that it is older than the Late Triassic granodiorite (uTrgd) that shows only a local, moderately developed foliation.

FOLIATED LEUCOGABBRO (uTrlg)

Within the Stuhini Group are strongly to weakly foliated hornblendepyroxene leucogabbro (plagioclase content to 50 per cent) and gabbro bodies that are probably related to Stuhini basaltic volcanism, The Late Triassic granodiorite (uTrgd) intrudes the eastern margin of this unit.

LATE TRIASSIC GRANODIORITE (uTrgd)

A potassium feldspar porphyritic, coarse to medium-grained hornblende-biotite (15% and 5% respectively) granodiorite (60% feldspar, 20% quartz) underlies a large portion of the centre of the field area. Stuhini conglomerate unconformably overlies or is faulted against the eastern contact of this pluton, while the western contact is an intrusive and faulted contact with foliated leucogabbro (uTrlg). Bultman (1979) obtained a K-Ar hornblende age of 215 ± 35 Ma on this body. This granodiorite is similar to Late Triassic plutons that intrude Nisling rocks west of the Llewellyn fault and Tally Ho shear zone along much of their lengths (Mihalynuk *et al.*, 1989; Hart and Pelletier, 1989).

MID-CRETACEOUS GRANITE (mKg)

A large biotite granite (biotite 15%, quartz 35%, feldspar 50%) body intrudes Nisling rocks and older intrusive bodies west of the Llewellyn fault. Epidote alteration has affected this granite and biotite grains have a greenish tinge.

EOCENE GRANODIORITE (Egd)

A small (400 square metres) outcrop of very fresh, white, biotite granodiorite (biotite 20%, quartz 20%, feldspar 60%) is exposed within the mid-Cretaceous granite. The lack of alteration and difference in composition suggest that this is a distinct and probably younger plutonic body. No published radiometric ages constrain this unit.

TERTIARY CATHEDRAL GRANODIORITE (Tgd)

The Cathedral granodiorite caps Cathedral Mountain in the centre of Figure 1-17-2 and received only cursory attention in this study. Where observed, the intrusive body is a white to grey-weathering biotite granodiorite to quartz diorite.

NEODYMIUM ISOTOPIC STUDIES

The presence of metamorphic clasts and porphyritic granodiorite clasts within the Stuhini conglomerate strongly suggests that the Nisling assemblage and related intrusive rocks served as a source area for detritus deposited into basins associated with the northern Stikine assemblage. One way to quantitatively test this hypothesis is to characterize the neodymium isotopic signature of the sedimentary rocks in the northern Stikine Terrane. Previous isotopic studies show that much of the Nisling assemblage is composed of detritus from older source regions that were at least in part Proterozoic in age. L. Werner (in Monger and Berg, 1987) reported a 900 Ma rubidium-strontium isochron from Nisling lithologies. Samson *et al.* (1989a) interpreted an early Proterozoic neodymium mantle separation age for material in the Nisling Rocks. Gehrels *et al.* (in press) report an early Proterozoic source for detrital zircons in the Nisling assemblage based on uranium-lead geochronologic analyses.

If detritus from the Nisling Terrane is present in Stuhini sedimentary rocks and has been incorporated into plutons that intrude these strata, neodymium isotope data should show a distinct mixing of Proterozoic material with younger, mantle-derived material from the Stikine volcanic rocks. To determine if this is the case, we have collected 12 samples in the Willison Bay area (list of sample localities given in Table 1-17-1) and 65 other samples from northern British Columbia and southern Yukon. This sample suite will provide provenance signatures for the northern Stikine Terrane and overlapping sedimentary strata of the Lower to Middle Jurassic Laberge Group and Upper Jurassic to Lower Cretaceous Tantalus Group.

TABLE 1-17-1

Sample Number	Unit	Location (UTM)
89-AT-070	Late Triassic granodiorite	517-691
89-AT-073	mid-Cretaceous granite	492-682
89-AT-074	Eocene(?) granodiorite	483-684
89-AT-075a	mid-Cretaceous granite	480-702
89-AT-076a	foliated granodiorite	470-698
89-AT-078	Late Triassic foliated leucogabbro	498-697
89-AT-080	Upper Triassic pyroxene-phyric basalt	549-724
89-AT-081	chlorite schist clast in Late Triassic conglomerate	532-700
89-AT-098	Jurassic Laberge siltstone	545-757
89-AT-100	Upper Triassic fine-grained sandstone	533-723
89-AT-101	Upper Triassic grey argillite	542-711

Locations of neodymium-strontium isotopic samples collected in the Willison Bay area. Sample sites are shown in Figure 1-17-2 (note that only the last three digits are given on the map). Locations are UTM grid references; all are within NTS sheet 104M/8, Edgar Lake.

REGIONAL TECTONIC SIGNIFICANCE

If Upper Triassic Stuhini Group strata of the northern Stikine Terrane unconformably overlie, or received detritus from Nisling assemblage rocks, then this northern portion of the Stikine Terrane may be somewhat different from its southern counterpart. In the south, Anderson (1989) interprets Upper Triassic Stuhini rocks to lie unconformably on the Stikine assemblage, a succession of Devonian to Permian limestones and arc-type volcanic rocks. Samson *et al.* (1989b) studied the neodymium and strontium isotopic signature of southern Stikine rocks and concluded that much of this assemblage has a primitive isotopic signature, with rocks consisting primarily of new additions from the mantle rather than recycled continental material. This study will serve as a basis for comparison with previous isotopic work in the southern part of the Stikine Terrane and will provide more rigorous, quantitative constraints for relationships between units in the northern part of the terrane.

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NOTES