STRATIGRAPHY AND STRUCTURE IN THE TWIN GLACIER – HOODOO MOUNTAIN AREA, NORTHWESTERN BRITISH COLUMBIA (104B/14)

**By Jeffrey A. Fillipone and John V. Ross
The University of British Columbia**

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INTRODUCTION

The Iskut River area of northwestern British Columbia is underlain by a thick succession of upper Paleozoic and Mesozoic volcanic rocks which host a number of significant base and precious metal prospects. Near Bronson Creek, a tributary of the Iskut River, the Johnny Mountain deposit is currently being mined by Skyline Explorations Ltd. and the Snip deposit is being developed for production by Cominco Ltd.

During the summer of 1988, two weeks were devoted to mapping a sequence of volcanic and sedimentary rocks which outcrop on the north side of the Iskut River, north of Bronson Creek (Figure 1-31-1). An attempt was made to document all stratigraphic and structural features that might have bearing on the geologic evolution of nearby areas of economic interest.

PREVIOUS WORK

Regional geological maps cover overlapping areas but present many disparate descriptions of probably equivalent rocks comprising the Triassic and Jurassic successions (Kerr, 1948; Grove, 1986). Kerr mapped the area in the vicinity of the Iskut and lower Stikine rivers, and devised a generalized regional stratigraphy including upper Paleozoic sedimentary and volcanic rocks, Permian limestone, Triassic and Jurassic sediments and volcanics, and numerous, mostly Mesozoic intrusive rocks. Mapping in the Telegraph Creek area (104/G) by the Geological Survey of Canada (1957) as part of Operation Stikine, and later by Souther (1972) documents Triassic and Jurassic rocks exposed northeast of the study area, along the Iskut River valley. Lefebure and Gunning (1988) mapped the area south of the Iskut River near Bronson and Snippaker creeks, and compiled geochemical data on major gold properties and prospects. This study will complement mapping by the British Columbia Geological Survey Branch in the Unuk River and Sulpurets areas to the south (Britton and Alldrick, 1988; Britton *et al.*, 1989, this volume) and in the Scud river area to the north (Logan and Koyanagi, 1989; Brown and Gunning, 1989, both this volume).

Upper Paleozoic and Mesozoic rocks in the Iskut River area comprise part of the Stikine terrane of northwestern British Columbia (Wheeler and McFeely, 1987). Stratigraphic descriptions of the Mesozoic succession are limited to the work of Kerr (1948) and numerous mineral property assessment reports, which generally lack details of the age relationships and stratigraphy. Rocks mapped in this study are part of Kerr's Unit 11, which he described as intermediate to basic lavas, tuffs, clastic rocks and limestone, cut by a variety of intrusions.

Souther (1971) applied the term Stuhini Group to Triassic volcanic rocks in the Tulsequah map area which may be correlative with similar strata in the Stewart area (Grove, 1971, 1986). Recent geological compilation of the Canadian Cordillera includes rocks of the study area in the Stuhini Group (Wheeler and McFeely, 1987). This paper presents an interpretation of the detailed stratigraphy on the ridge separating Twin Glacier and a nearby area on the north flank of Hoodoo Mountain, a Quaternary volcano. Units are correlative across the extensive icefield separating these two areas (Figures 1-31-1 and 1-31-2).

STRATIGRAPHY

The map area is underlain by a package of interlayered intermediate to mafic volcanogenic sediments and volcanic flows. At Twin Glacier these rocks generally dip moderately to steeply southwest, with some northerly dips resulting from obvious macroscopic folds. In contrast, the same units near Hoodoo Mountain have steep to near-vertical dips to the north and south. Primary sedimentary structures were used to determine stratigraphic tops and they indicate most of the succession (Units 1 to 6) at Twin Glacier is overturned; the steeply dipping strata near Hoodoo Mountain are both right-way-up and overturned. The following descriptions of stratigraphic units are ordered from oldest to youngest, based on this interpretation.

UNIT 1

Unit 1, a sequence of well-layered basaltic to andesitic flows, basic to intermediate tuffs, minor limestone and argillite, at least 700 metres thick, crops out at the south end of Twin Glacier ridge. Compositional layering is laterally continuous and individual flows vary from 10 to 50 centimetres in thickness, with most between 20 to 30 centimetres thick. Light grey recrystallized limestone occurs as thin lenses, mostly within the basalt flows. At the extreme southern end of the ridge silty tuffs and poorly bedded siltstone become more abundant. Thinly laminated, light grey calcareous tuff with quartz phenocrysts occurs near the base of the unit.

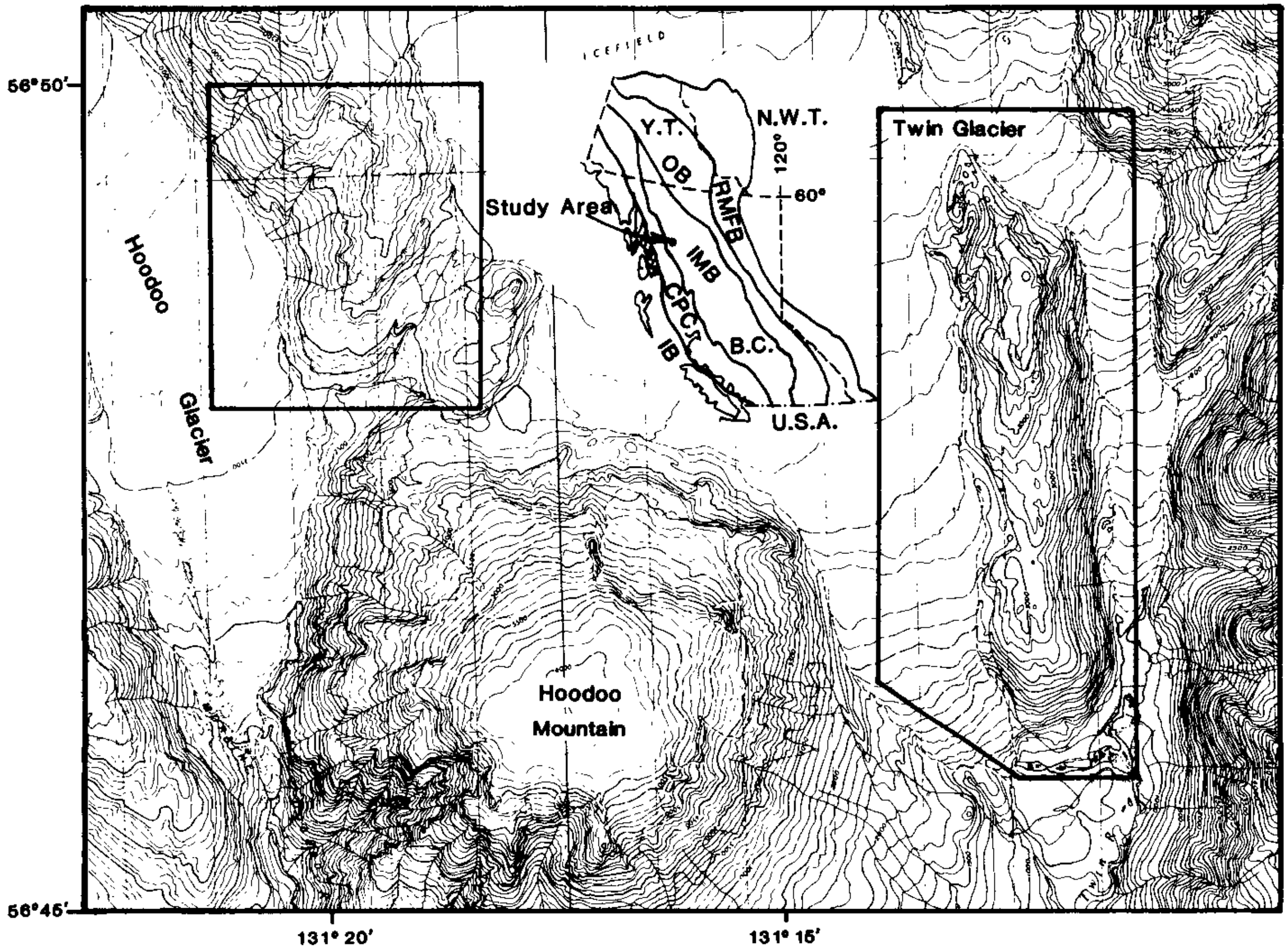

Figure 1-31-1. Location map of the Twin Glacier – Hoodoo Mountain area, northwestern British Columbia with boundaries of the individual map areas. Inset shows relationship to major tectonic belts of the Canadian Cordillera. Belt abbreviations are as follows: RMFB = Rocky Mountain fold and thrust belt; OB = Omineca Belt; IMB = Intermontane Belt; CPC = Coast plutonic complex; IB = Insular Belt.

Recrystallization and coarsening of micas has clearly taken place due to an apparent increase in metamorphic grade. Paleozoic rocks mapped by Kerr (1948) at the south end of Twin Glacier are probably the slightly higher grade(?) metamorphic equivalents of Unit 1.

UNIT 2

Unit 1 is followed, in continuous progression, by a sequence of interlayered basalt, rhyolite and rhyodacite at least 450 metres thick (Figure 1-31-2a). Interlayered basalt and carbonate of Unit 1 are succeeded by similar basalt with layers and pods of rhyolite and/or rhyodacite 1 to 5 metres thick. Light to dark grey, very fine-grained, strongly flow-banded siliceous volcanics, mainly flows, alternate with layers of basalt 1 to 3 metres thick, and minor lenses of recrystallized limestone (Plate 1-31-1). The siliceous volcanics locally form large flow-banded pods and "pillowed" zones. Globular "pillows", 5 to 15 centimetres thick, locally impart a "pinch-and-swell" texture to the rock. Toward the top of Unit 2 rhyolite flows become thinner and less abundant.

UNIT 3

Unit 3, approximately 150 metres thick, comprises basalt (40 per cent), almost identical to that of Unit 2 and the lower part of Unit 1, and graded beds of silty to fine-grained green and purplish tuff with minor argillite and lapilli tuff horizons. The silty tuffs are locally interlayered with discontinuous fine cherty bands 1 to 3 millimetres thick; the coarser tuffs contain diverse fragments of tuff, dark grey mudstone, light green fine-grained volcanic rocks and feldspar crystals. Individual grains range from less than 1 millimetre to 1 centimetre or more in diameter.

UNIT 4

The base of Unit 4 is defined by rusty weathering basalt in contact with bedded tuff of Unit 3. The unit comprises 600 metres or more of basalt and minor tuff passing upwards into

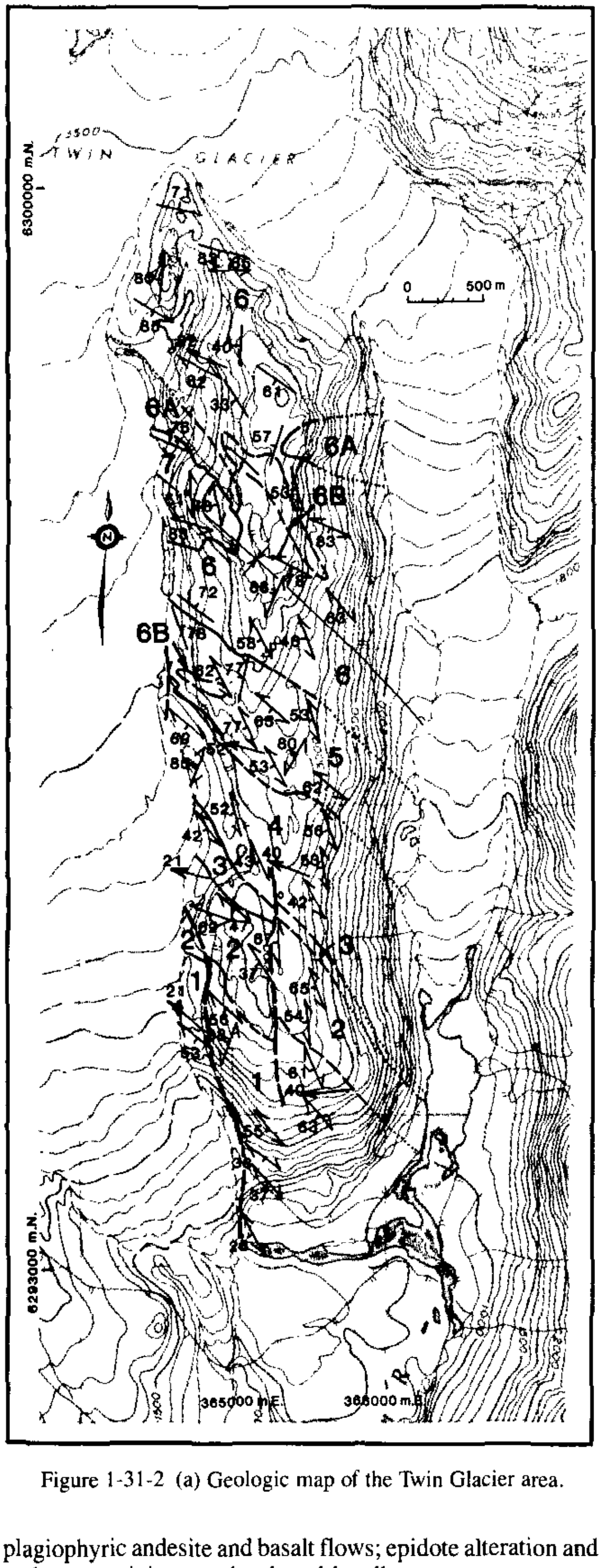

Figure 1-31-2 (a) Geologic map of the Twin Glacier area.

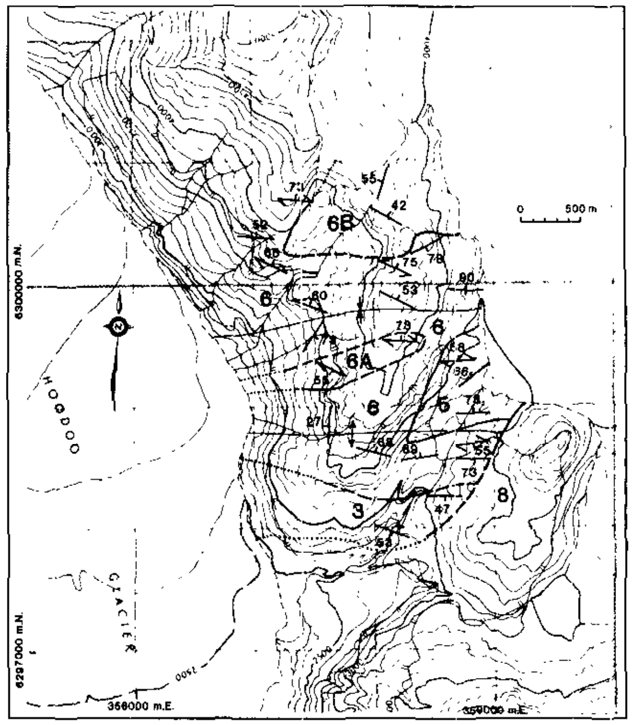

Figure 1-31-2 (b) Geologic map of the Hoodoo Mountain area.

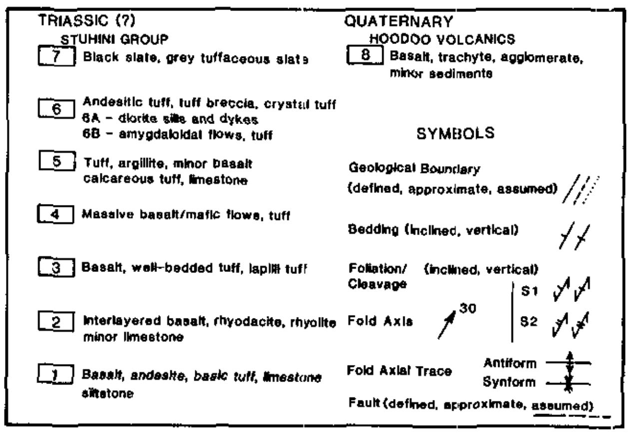

Figure 1-31-2 (c) Legend for geologic maps.

plagiophyric andesite and basalt flows; epidote alteration and carbonate veining are developed locally.

UNIT 5

Unit 5 is a structurally complex package of grey phyllite and slaty tuff, black argillite, and calcareous tuff, 450 or more metres thick. A thin discontinuous calcareous tuff at the base of the unit is overlain by fine-grained slaty tuff and a layer of dark grey plagiophyric basalt 1 to 1.5 metres thick. Locally, a thin sill of light brownish grey porphyritic rhyolite or rhyodacite occurs above the slaty tuff; it is very fresh and undeformed, and contains plagioclase laths a centimetre or more long. Above the sill is a zone of purple to grey phyllite overlain by very fine-grained, black sooty argillite or slate containing small pyrite grains preferentially developed along cleavage planes. The black slate contains thin layers of plagiophyric basalt almost identical to that above the slaty tuff lower in the section. Basalt flows are also intercalated with black slates within the calcareous tuff sequence that comprises the rest of the unit. The calcareous tuff is massive to slaty and contains fragmental zones where lapilli of tuffaceous material make up 20 to 30 per cent of the rock.

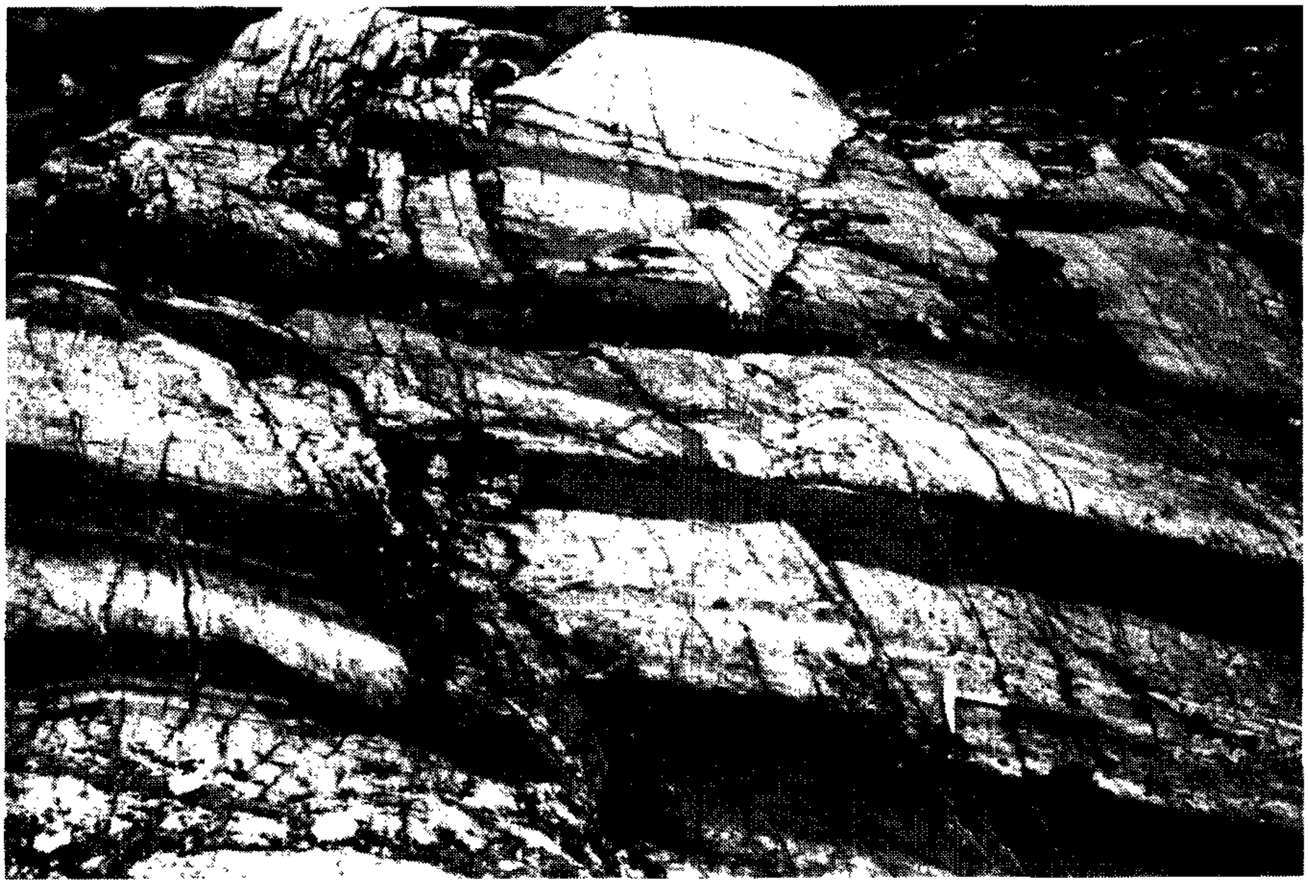

Plate 1-31-1. Alternating bimodal flows of basalt (dark layers) and plagiophyric siliceous volcanics (rhyodacite?).

UNIT 6

Unit 6 is a distinctive resistant succession of pale green-weathering, well-bedded tuff, tuff breccia or agglomerate, and crystal tuff, intruded by diorite dykes and sills, and having an aggregate thickness in excess of 900 metres. The contact with calcareous tuffs of Unit 5 is a low-angle unconformity. Massive, unfoliated hornblende crystal tuff, and what is interpreted to be coeval diorite (Subunit 6A), are commonly overlain by beds of medium to coarse-grained silty tuff and tuff breccia containing angular to subrounded fragments. The tuffs include well-developed graded beds indicating that this unit is right-way-up; both normal and reverse grading are observed. Augite is a major component of tuffs throughout Unit 6, especially in the finer grained rocks, occurring as phenocrysts, glomerophenocrysts and small lath-shaped grains in a fine-grained devitrified matrix. Feldspar is invariably altered to epidote, sericite and oxides. The breccias incorporate blocks of tuff and fine-grained volcanic rocks of similar composition to the matrix. Fragments are generally lapilli size but include subangular to subrounded blocks up to 25 centimetres long.

In the upper part of the unit ocassional beds of dark grey mudstone, 1 to 4 metres thick, occur in bedded tuffs and, north of Hoodoo Mountain, pale green tuff locally grades into thinly laminated to slaty, maroon lithic tuff.

Subunit 6B consists of zones of dark grey amygdaloidal flows near the base of the well-bedded tuffs. Large irregular bodies of diorite (subunit 6A) at the base of Unit 6 crosscut bedding in the underlying black slate and argillite of Unit 5; one diorite body lies wholly within Unit 5 (Figure 1-31-2a).

Convolute laminations are common where thinly bedded tuff is overlain by very coarse agglomerate and may indicate a base-surge origin for some of the finer grained pyroclastic material (Fisher and Schminke, 1984). Rare examples of small-scale load structures and channel scours have been observed at similar contacts where coarse clastic beds have been deposited on top of much finer grained material (Plate 1-31-2). Cross-stratification was not seen, although carefully looked for. These sedimentary structures are interpreted as evidence of deposition in a shallow marine environment close to a volcanic centre.

UNIT 7

Black slates and grey tuffaceous slates, 200 metres thick, comprise the youngest stratigraphic unit exposed in the study area. Bedding, manifest as colour bands several centimetres wide or as alternating beds of light coloured silly slate and black fine-grained slate 10 to 30 centimetres thick, is strongly folded throughout the unit but there is no evidence of discordance with underlying beds of Unit 6.

Plate 1-31-2. Graded beds in tuff breccia and well-bedded tuff in Unit 6, Twin Glacier.

Plate 1-31-3. F_2 minor folds in Unit 5 bedded tuff; view down plunge to the south-southwest (approximately 200° azimuth).

STRUCTURE

The study area covers only a small segment of the large fold structures which characterize the region (Kerr, 1948; Grove, 1986). Nevertheless, minor structures and stratigraphic top indicators can be used to interpret the major structural features of the area. Lower hemisphere equal-area projections of planar and linear structures at Twin Glacier and north of Hoodoo Mountain are presented in Figures 1-31-3 and 1-31-4. Structural data from the two areas, and from above and below the unconformity between Units 5 and 6, are plotted separately.

FOLDING

The plots presented in Figures 1-31-3 and 4 indicate two superimposed deformational events. The first phase of folding (F_1) and its related cleavage, are developed along a northwest trend. Best-fit girdles of deformed bedding indicate a trend of 280 to 300 degrees for F_1 fold axes (Figure 1-31-3a, 3c), except where modified by pre-existing unconformities or subsequent folding. F_1 minor folds are preferentially developed in the fine-grained clastic units such as black mudstone (slate). Axial planes are moderate to steeply dipping with hinge lines generally plunging gently to the northwest. Minor folds are open to tight, and exhibit asymmetry from which a general northeast sense of vergence is deduced. S_1 fabrics are generally nonpenetrative and in rare instances have an incipiently recrystallized mica fabric parallel to cleavage planes.

F_2 folds have an open, upright style, and steeply dipping axial surfaces with a trend almost orthogonol to F-1 structures (Figure 1-31-3e). A nonpenetrative spaced cleavage typifies the S_2 fabric (Plate 1-31-3). A possible interpretation of the significant change in the orientation of S_1 between the Twin Glacier and Hoodoo Mountain localities (Figure 1-31-4) is that large wavelength F_2 folds have refolded earlier structures about predominantly southwest-plunging fold axes – L_2. This is supported by the observation that F_2 folds distort L_1 linear structures at Twin Glacier. F_2 minor folds were not documented with certainty at Hoodoo Mountain.

A slaty cleavage striking 220 to 240 degrees and dipping 40 to 65 degrees northwest was observed at a few localities, in several different lithologies, however, its significance is not yet understood.

FAULTS

Few significant faults were recognized in the map area. One fault cuts bedding in Unit 5 at a shallow angle (Figure 1-31-2a) and appears to ramp up-stratigraphy within the unit, producing a minimum offset of 10 metres reverse movement (hangingwall up to the southwest). The fault has been distorted by F_2 folds and is probably related to the earlier deformation event. Younger, north-trending, steeply dipping faults with small offsets, mapped on the west side of Twin Glacier ridge, cut bedding at a high angle and are probably related to F_2 deformation.

VEINS

Brittle structures related to post-F_1 deformation are common throughout the area. Extension gashes, some of which are sygmoidal in shape, are filled with calcite, or rarely quartz, and are especially abundant in basalt and well-indurated tuff of Units 3 through 7. Sigmoidal gashes record progressive deformation of complex geometry. Many extension fractures, with or without vein fillings, are subparallel to the S_2 cleavage (Figure 1-31-3f). Syntaxial calcite veins in

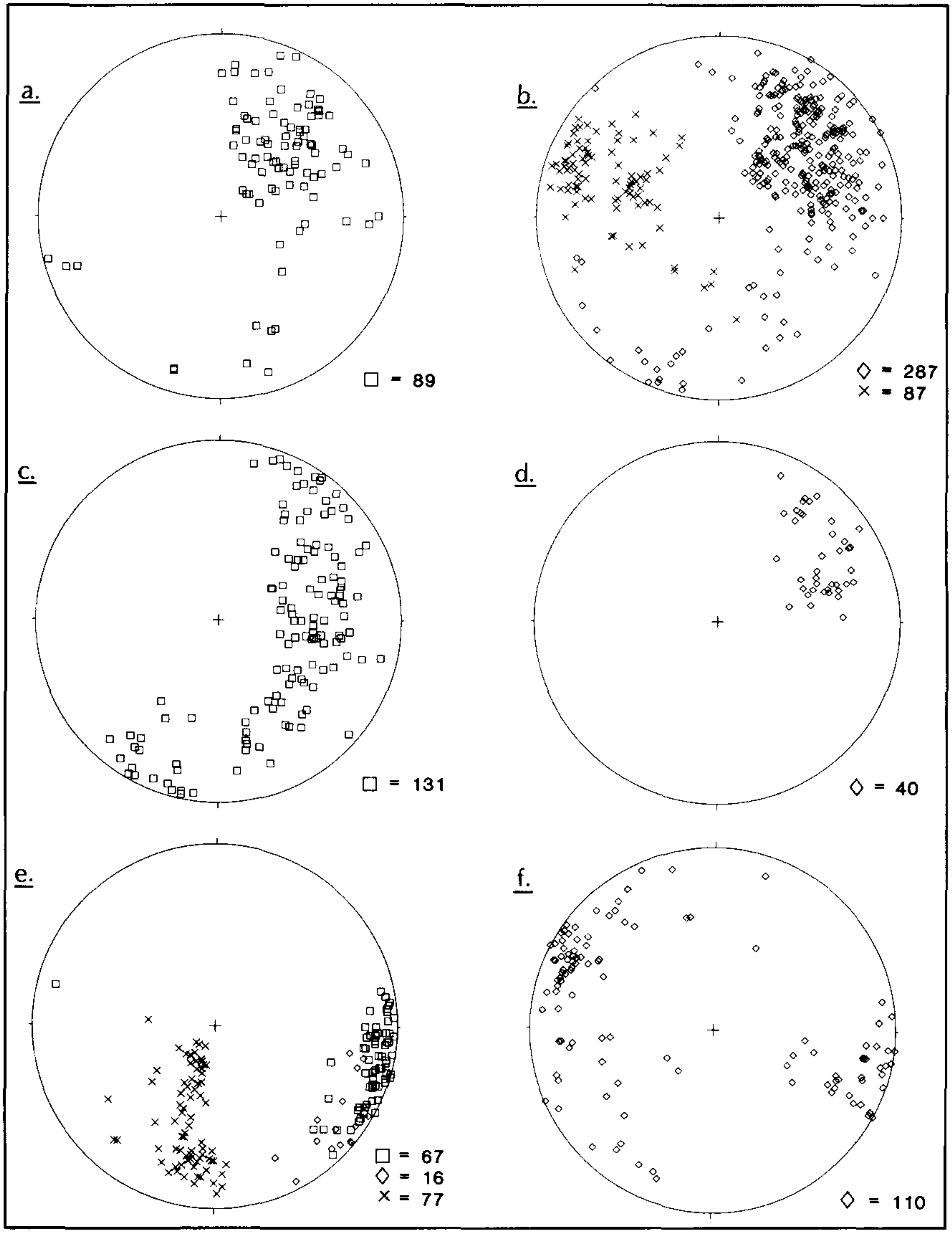

Figure 1-31-3. Twin Glacier area – lower hemisphere, equal-area projections of poles to bedding (S_0), poles to foliation planes/minor fold axial plants (S_1, S_2) and F_1 fold axes/intersection lineations (L_1, L_2). Symbols are as follows: boxes = bedding; diamonds = foliation (except for (f) which represent poles to fractures); X = fold axes. (a) S_0 data, Units 1-5; (b) F_1 data, Units 1-5; (c) S_0 data, Units 6, 7; (d) S_1 data, Units 6, 7; (e) F_2 data, all units, undivided; (f) extension fractures/gashes (diamonds = poles).

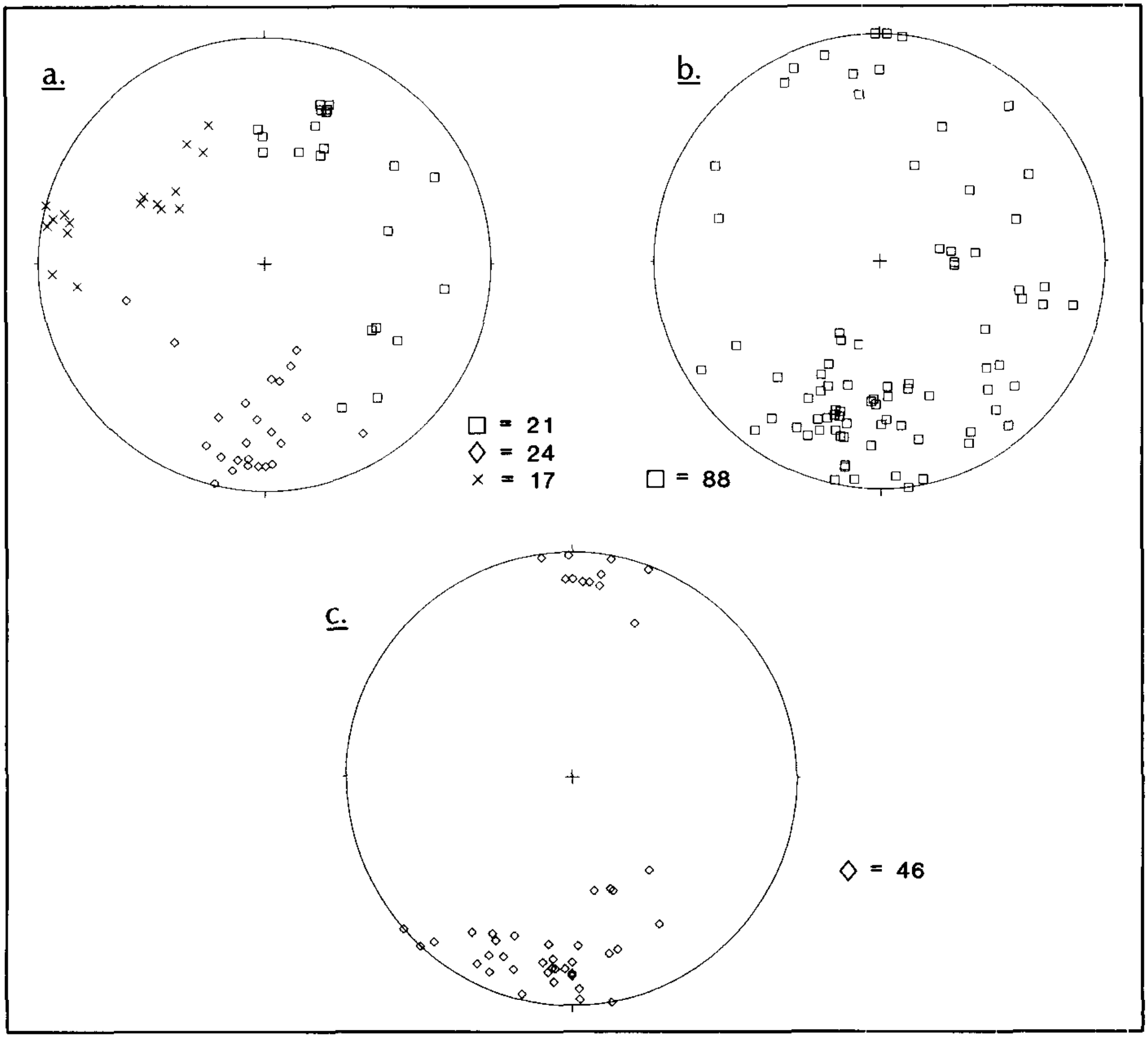

Figure 1-31-4. North of Hoodoo Mountain – lower hemisphere, equal-area projections of poles to bedding (S_0), poles to foliation planes/minor fold axial planes (S_1) and F_1 fold axes/intersection lineations (L_1). Symbols are as follows: boxes = bedding; diamonds = foliation; X = minor fold axes. (a) S_0, S_1 and L_1 data, Units 3-5; (b) S_0 data, Unit 6; (c) S_1data, Unit 6.

basalt and calcareous tuff frequently show crack-seal textures (Ramsay, 1980) and locally carry small amounts of pyrite.

METAMORPHISM

Lower greenschist metamorphism synchronous with F_1 deformation has affected all units. Fine-grained phyllite contains a muscovite-chlorite-albite-epidote metamorphic assemblage; original calcite, quartz, hornblende and iron oxides are preserved in many of the volcanic rocks. Patches of very fine-grained biotite are developed in phyllite of Units 4 and 5. In places the rims of calcite amygdules in basaltic lavas are altered to chlorite and/or epidote. Fine-grained schists, metagreywackes and basic to intermediate volcanic rocks at the Snip property exhibit biotite-grade metamorphism, implying increasing metamorphic grade south of the Iskut River. Mineralization at Snip is probably early synmetamorphic as the ore zones are deformed by F_1 folds.

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