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GEOLOGY OF THE TODAGIN PLATEAU AND KINASKAN LAKE AREA NORTHWESTERN BRITISH COLUMBIA (104H/12, 104G/9)

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INTRODUCTION

This report presents results from the second year of field mapping, as part of the Tatogga Lake project.

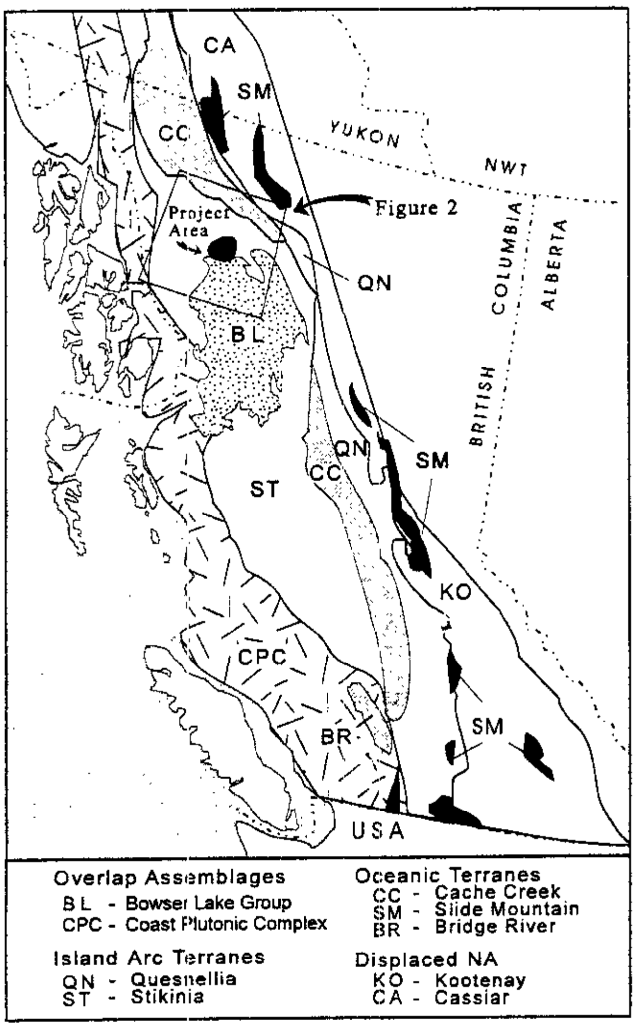

Figure 1. Regional geological setting of the Tatogga Lake project area.

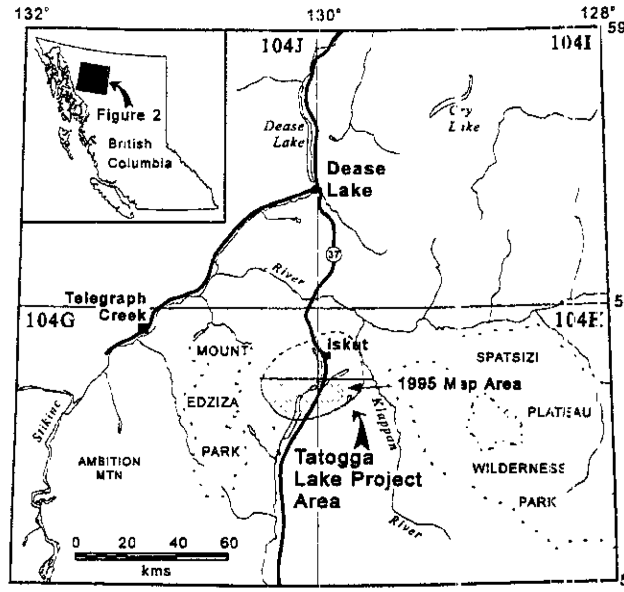

Figure 2. Geographic location of the Tatogga Lake project showing area covered in this report.

This is a geologic and metallogenic mapping program initiated in 1994 to investigate the geology and associated mineral deposits of Stikine Terrane Mesozoic arc-volcanic rocks along the northern margin of the Bowser Basin in northwestern British Columbia (Figure 1; Ash *et al.*, 1995). The project area is located 80 kilometres south of Dease Lake, and is transected by the Stewart-Cassiar Highway (Highway 37), south from the village of Iskut (Figure 2). It includes parts of NTS map sheets 104G/9 and 16, and 104H/12 and 13.

During 1995, fieldwork was conducted from July 6th to September 12th and focused primarily on the southern half of the project area (Figure 2). The 1995 map area encompasses the northwest corner of the Kluea Lake (104H/12) map sheet (Figure 3) and the northeast part of the Kinaskan Lake (104G/9) sheet (Figure 4). The eastern half of the map area (Figure 3) encompases most of the Todagin Plateau and is referred to here as the Todagin map area. A preliminary 1:20 000-scale geology map of the Todagin area, which includes the Red-Chris porphyry copper-gold deposit, has been produced as part of this work (Ash *et al.*, 1996). Mapping of the Kinaskan Lake sheet (104G/9) was only partially completed due to

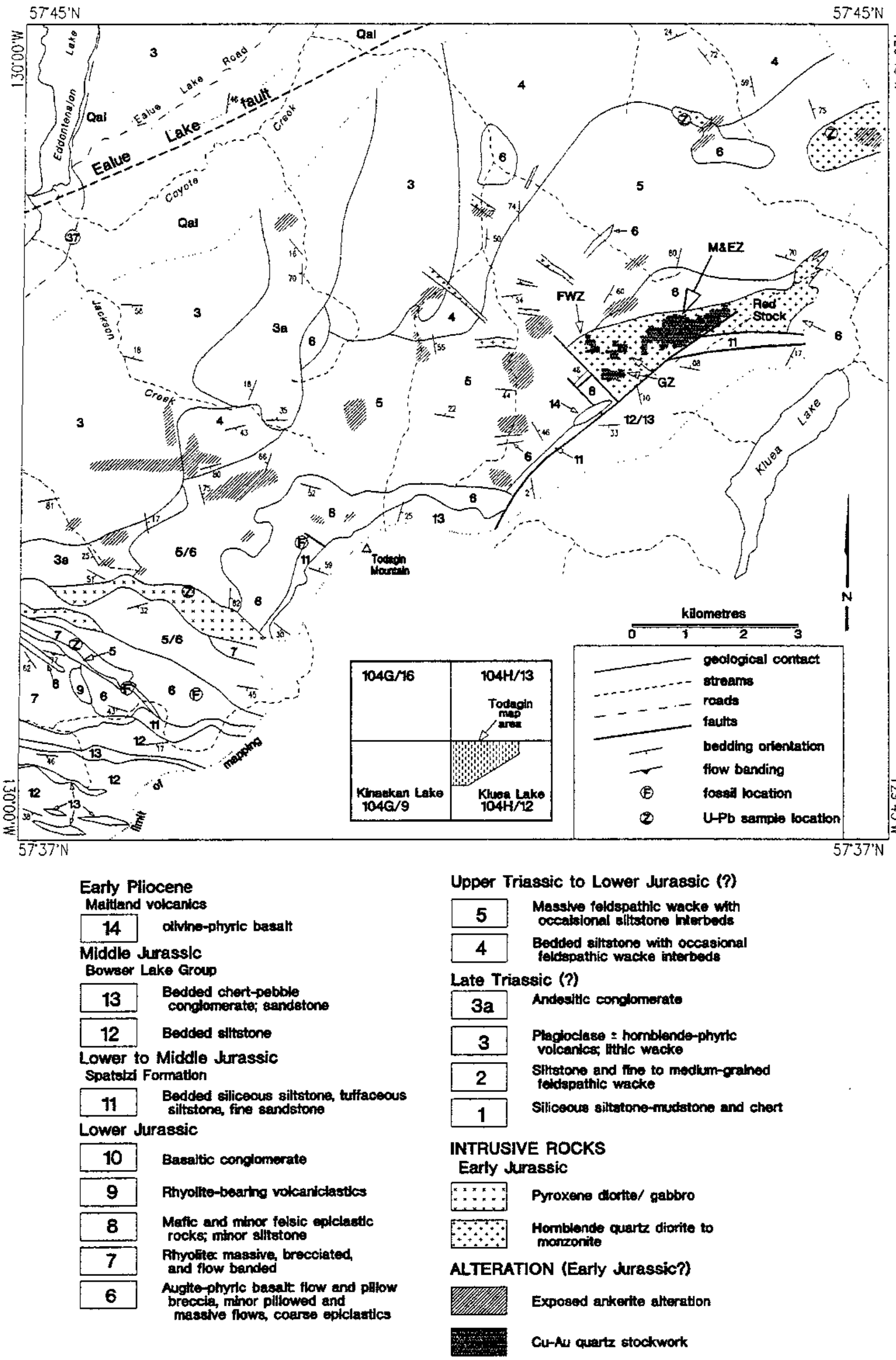

Figure 3. Geology of the Todagin Plateau. E&MZ = East and Main zones, GZ = Gulley zone, and FWZ = Far West zone of the Red-Chris deposit.

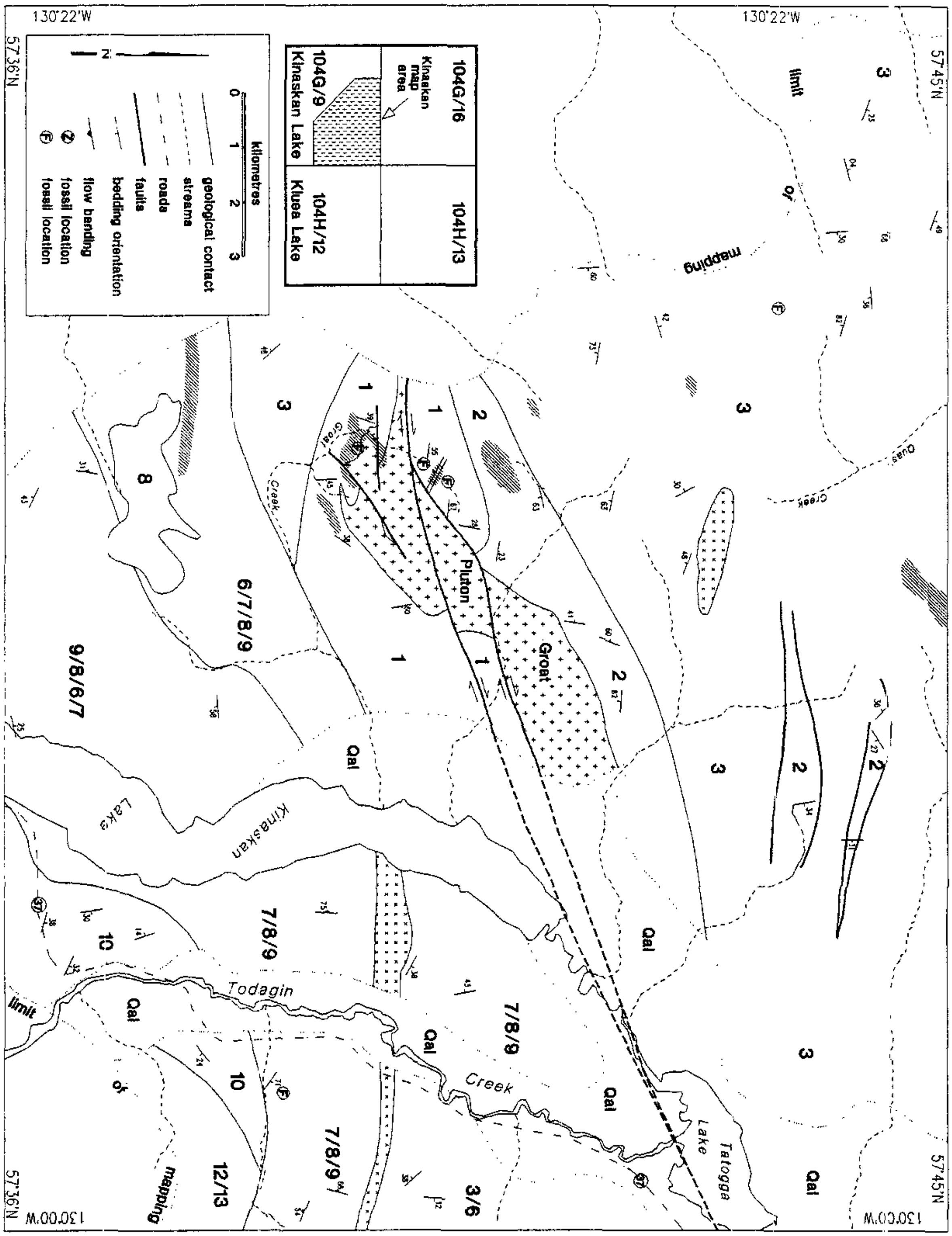

Figure 4. Geology of the Kinaskan Lake area. For legend, see Figure 3.

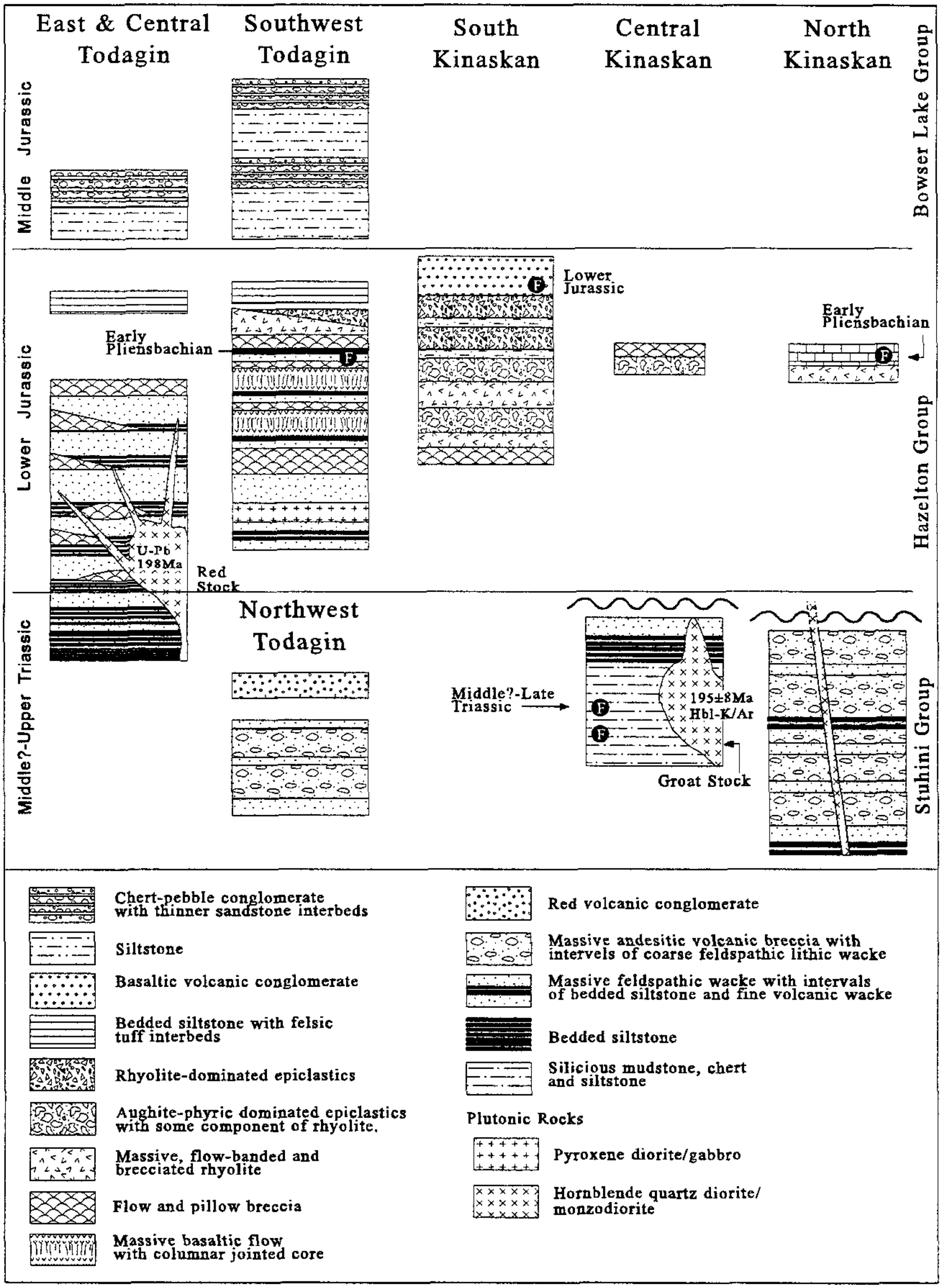

Figure 5. Schematic stratigrasphic sections for the southern half of the Tatogga Lake project area.

extended periods of inclement weather. Accordingly, geological units shown on this sheet remain largely undifferentiated. Results of mapping for this sheet will be released in open file format following completion of mapping, planned for the 1996 field season.

Exploration activity in the area this year was once again dominated by American Bullion Minerals Ltd. which completed its second season of intensive delineation and exploration drilling on the Red-Chris deposit. Drilling was successful in increasing previously defined potential mineable reserves in the East and Main zones and identified two new areas of copper-gold mineralization southwest of the Main zone in the Gully and Far West zones. The latter two zones are collectively referred to as the Yellow Chris. Other exploration activity in the area included a preliminary evaluation of the Klappan group of claims by Homestake Canada Inc. and regional work by Teck Corporation.

For a discussion on aspects of previous work, physiography and regional setting for the project area the reader is referred to Ash *et al.* (1995).

LOCAL GEOLOGY

The map area is underlain almost entirely by Upper Triassic and Lower Jurassic arc-volcanic rocks that are overlain along their southeastern margin by Middle Jurassic Bowser Lake Group sediments (Figures 3 and 4). These Mesozoic volcanic rocks are divisible into three broad northeast-trending belts. The northwestern belt is dominated by Middle(?) to Upper Triassic andesitic volcaniclastics, mainly massive breccias. The central belt is underlain primarily by Upper Triassic and possibly Lower Jurassic fine to medium-grained epiclastic rocks. Lower Jurassic rocks comprise a bimodal suite of basalts and rhyolites and related subvolcanic rocks that overlie and intrude very fine to medium-grained sedimentary rocks primarily to the southeast. The younger rocks also locally intrude and overlie Triassic rocks throughout the map area.

These rocks have been affected by folding and faulting. Mesoscopic folding is generally only identified within the Lower Jurassic and older, thinly bedded sediments, mainly siltstones, and rarely in limestones. Broad warping of thicker bedded sequences is a characteristic megascopic feature commonly seen in cliff exposures. High-angle brittle faults are abundant throughout the map area and contacts are rarely exposed. As a result it is difficult to establish continuity of contacts between individual Mesozoic volcanic units.

Stratigraphic relationships within individual sections are, however, locally well displayed. The following discussion focuses primarily on local and regional stratigraphic variations. Individual areas with some degree of stratigraphic continuity are separated and their stratigraphy is summarized in a series of generalized sections (Figure 5) keyed to the discussion. Sections are not to scale with respect to thickness or time; the thickness of some sections is exaggerated to show detailed relationships. Most of the Lower Jurassic sections, for example, probably represent a short interval between 200 and 193 Ma (Sinemurian to Pliensbachian).

LATE TRIASSIC STRATIGRAPHY

NORTH KINASKAN

Upper Triassic rocks represented in this section (Figure 5) underlie the northern half of the Kinaskan map area (Figure 4). The north Kinaskan area comprises a largely undifferentiated sequence of andesitic volcaniclastic rocks with lesser and related coarse to conglomeratic epiclastic sediments. Volcaniclastic rocks are dominated by massive, green, plagioclase±hornblende-porphyritic andesitic breccias, probably lahars or debris-flow deposits. Breccias vary from clast to matrix supported and are generally massive on the outcrop scale (Photo 1). Subangular to subrounded volcanic clasts, usually from 2 to 6 centimetres across, but ranging from one to several tens of centimetres in size, are set in a lithologically similar, fine to medium-grained fragmental matrix. Individual clasts vary in both phenocryst size and

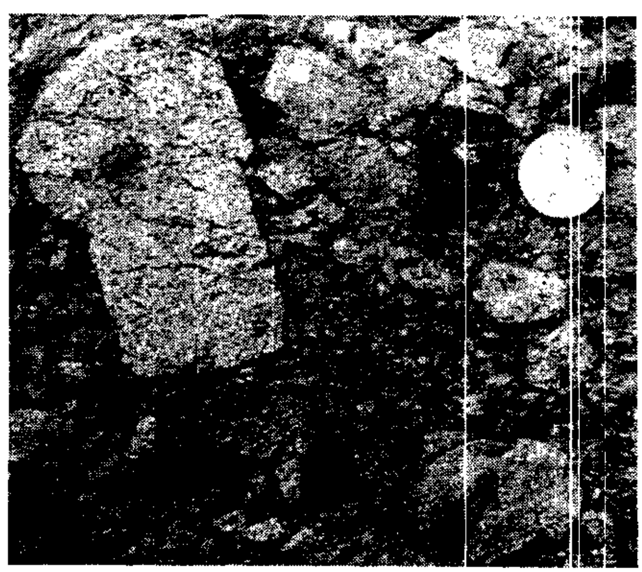

Photo 1. Andesitic volcanic breccia with plagioclase±hornblende-porphyritic clasts, north Kinaskan region.

abundance, containing from 15 to 30%, 1 to 3-millimetre, tabular plagioclase and lesser to trace amounts of hornblende phenocrysts of comparable size, in modal abundances of 3 to 10%. Locally, breccias are more heterolithic, containing aphanitic green volcanic and distinctive red-brown, angular, mudstone clasts in addition to the porphyritic clasts. Matrix material of the heterolithic breccias is more poorly sorted and displays a wider grain size variation than in the other breccia type. The more heterolithic breccias are also typically characterized by a maroon coloured matrix.

Epiclastic sediments include volcanic conglomerates, coarse feldspathic lithic wackes, massive, medium to coarse feldspathic wackes, and bedded siltstones. Volcanic conglomerates and wackes are found primarily as isolated, thickly bedded sequences from several metres to several tens of centimetres thick within the thicker successions of massive volcanic breccias (Photo 2). Bedding in most of this unit typically strikes between west-northwest and west-southwest with moderate dips to the north and south. Several fault blocks near the north edge of the Kinaskan Lake sheet are underlain by much thicker sections of similar lithologies.

Cooper (1978) established a Late Triassic age for this unit several kilometres to the north of the Kluea Lake sheet. This was based on the presence of the pelecypod *Monotis* in limestone interlayered with and overlain by andesitic volcaniclastic rocks in that area. Similarly, Souther (1972) collected *Monotis* fauna from sediments in the northern Kinaskan area lithologically comparable to those described by Cooper. Souther also established that fossiliferous sediments in this area are conformably overlain by the volcaniclastic rocks.

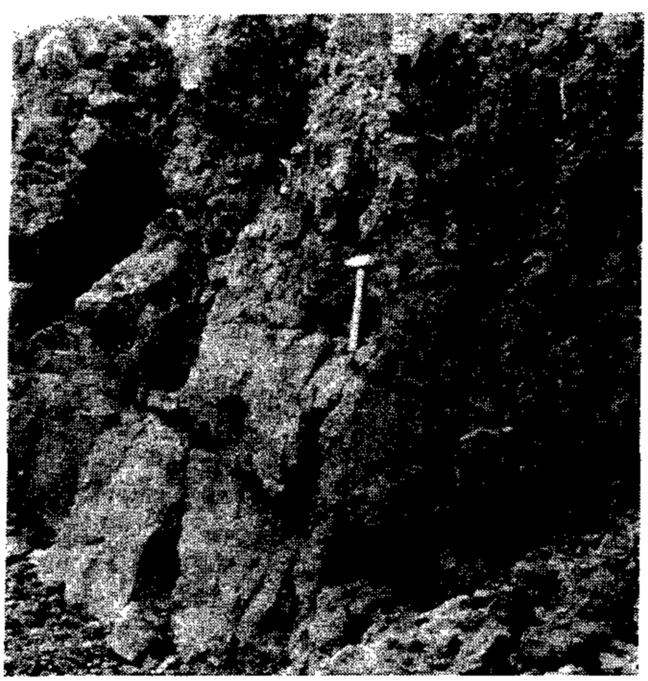

Photo 2. Andesites volcanic breccia overlying thickly bedded, coarse feldpathic lithic wacke,. north Kinaskan region.

CENTRAL KINASKAN

Fine-grained clastic and pelagic sedimentary rocks that include fine to medium-grained volcanic wacke, siltstone, siliceous siltstone-mudstone and chert underlie the central part of the Kinaskan sheet (Figures 4 and 5).

Siltstones are dark grey-green and are commonly bedded on the 0.5 to 1-centimetre scale. Rare beds of pebble to cobble conglomerate, less than half a metre thick, containing clasts of plagioclase±hornblende-phyric andesite, occur locally within the siltstone. Siliceous mudstone and chert are dark grey to black and are less commonly bedded.

Three of six samples of siliceous or cherty material collected from near the southwest end of the Groat pluton contain radiolarian fauna indicating that the sequence is Middle(?) to Late Triassic (Ladinian(?)-Carnian-Norian) in age (Cordey, 1995).

A progressive southward increase in the proportion of silicious material in the finer grained clastics may indicate a local facies variation. This facies change is suggestive of a deepening marine environment toward the south and is consistent with the regional variation in Upper Triassic volcanic rocks, from subaerial to submarine in the same direction.

NORTHWEST TODAGIN

Upper Triassic rocks represented in the northwest Todagin section (Figure 5) underlie the northwest third of the Todagin map area (Figure 3). These are mostly massive green-grey andesitic volcanic breccias similar to those described in the north Kinaskan area. In addition to the breccia unit, a distinctive red-brown weathering conglomerate forms a belt trending northeast from the head of Jackson Creek (Figure 4). Pebble to cobble conglomerates are usually clast supported and beds range from less than 50 centimetres to over a metre in thickness. These are interbedded with thinner, red-brown, massive, coarse feldspathic sandstones similar to the matrix material of the conglomerates. Conglomerate clasts are predominantly rounded to subrounded, plagioclase±hornblende andesite with occasional intrusive clasts.

Conglomerate beds are generally flat lying throughout the belt, however, steeply dipping beds are also present locally. The unit is well exposed in a series of cliffs along the northeastern valley wall above

Jackson Creek where a section 100 to 200 metres thick is exposed. Here the conglomerate appears to overlie both the massive andesitic breccia unit and the feldspathic wacke-siltstone, however, contact relationships between the conglomerate and underlying units are not exposed.

LATE TRIASSIC(?) - LOWER JURASSIC STRATIGRAPHY

EAST AND CENTRAL TODAGIN

Massive, feldspathic volcanic wackes and bedded black siltstones, locally interbedded with laterally restricted zones of augite-phyric mafic volcanic rocks, underlie the northeastern and central parts of the Todagin map area. Minor amounts of rhyolitic epiclastic sediments are also present. Black to dark brown, bedded siltstone, with occasional thinner intervals of massive, fine to medium-grained feldspathic wacke, dominate the northeastern flank of the plateau. Towards the southwest, massive, medium to coarse-grained feldspathic wackes with occasional thinner intervals of interbedded siltstone and fine sandstone become more common and dominate in the central area. The progession from a siltstone-dominated succession to a wacke-dominated sedimentary sequence towards the south and southwest is suggestive of regional facies variation.

The feldspathic wackes weather tan-brown to buff-grey and are light grey on fresh surfaces. They are characteristically massive and lack obvious sedimentary structures. Typically they are fine to medium grained and equigranular, except for sparse, dark grey to black, angular siltstone fragments from 3 to 15 millimetres in size (Photo 3). The abundance of siltstone fragments is usually from 1 to 2%, but may increase to 20% near bedded siltstone intervals. Massive coarse-grained, poorly sorted varieties of the wacke, with similar siltstone fragments, are also seen locally.

Intervals of dark grey to black, bedded siltstone, ranging from less than a metre to several tens of metres in thickness, occur intermittently throughout the massive wacke sequence. Siltstones are either interbedded with massive volcanic wacke on a scale of several metres, or consist predominantly of continuous intervals of thinly laminated siltstone, and silicious siltstone over distances of several tens of metres. Siltstone beds are laminated to thinly bedded on a 5 to 15-millimetre scale. Siltstone units containing very fine grained volcanic wacke interbeds display well preserved sedimentary structures such as graded bedding, scour marks and load structures (Photo 4). Measurable bedding attitudes in the sedimentary sequence are obtained primarily from these siltstone intervals. As a result, bedding orientation data are

Photo 3. Typical weathering appearance of the massive feldspathic wacke, central Todagin Plateau. Note black siltstone fragments.

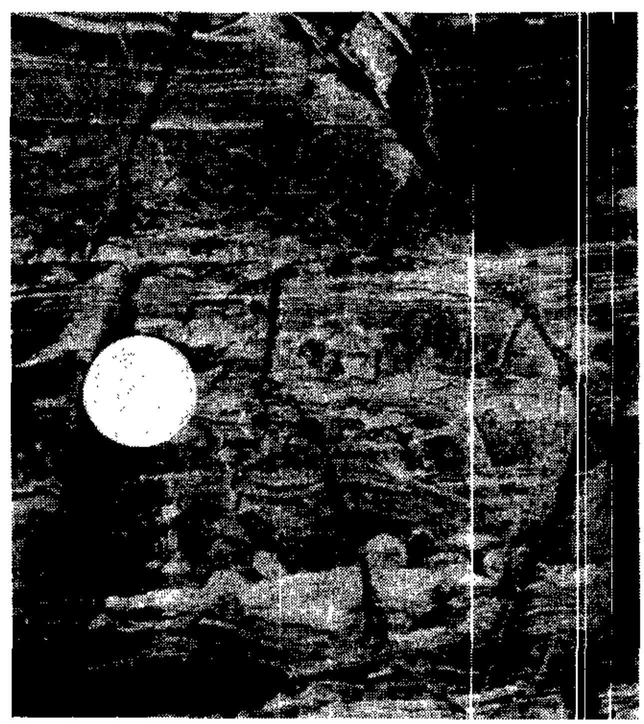

Photo 4. Interbedded siltstone and fine-grained feldspathic sandstone displaying well developed load casts, north central Todagin Plateau.

concentrated in northern and northeastern areas where siltstone is dominant. In the central area, where massive wackes dominate, siltstone intervals are much thinner and less common. In this area, bedding is constrained only locally. In spite of these limitations, a systematic variation in bedding orientation is evident within this sedimentary sequence. Bedding is everywhere moderate to steeply dipping. Along the northeastern flank of the plateau it typically strikes north or slightly east of north and towards the southwest appears to be progressively rotated into a northeast and then east orientation. Sedimentary structures usually indicate that bedding is right way up, but is locally overturned in some steeply dipping beds. This change in the bedding attitude is suggestive of a large-scale regional fold pattern, but this requires confirmation by detailed analysis of structural data.

We suspect that these feldspathic wackes may be in part coeval with, and possibly younger than the Upper Triassic breccia to the north and northwest, from which they are probably derived. A minimum age for this unit is constrained by crosscutting quartz diorite and quartz monzonite dikes and stocks that are dated as Early Jurassic (198 Ma) by U-Pb zircon methods (Friedman, 1995).

Throughout the east Todagin area, mafic volcanic rocks occur as laterally discontinuous, intermittent flow and pillow breccias with occasional coherent flows. Thicker intervals of the unit tend to be concentrated near the contact between Mesozoic volcanics and Bowser Lake sediments. For example, to the north of the Red stock, and northwest of Todagin Mountain, extensive outcrop areas of the unit are characterized by metre-scale flow layering (Photo 5). Volumetrically minor massive basaltic breccias, with clasts of augite-phyric volcanic in a coarse, angular lithic groundmass of similar composition, are also present locally within the thicker basaltic sections (Photo 6).

Basalts are dark olive-green with diagnostic 5 to 15%, black, euhedral augite phenocrysts from 1 to 4 millimetres in size. Rounded, white calcite amygdules, from 2 to 5 millimetres in diameter comprising from 5 to 20% of the rock, are common, though not ubiquitous. Where present, amygdules tend to weather out and impart a vesicular appearance to many exposed surfaces. Calcite veins and veinlets are a common feature of the unit.

Rhyolitic rocks are recognized as medium to coarse-grained bedded epiclastic sediments in a poorly exposed area at the western end of the Red stock. Rhyolitic volcanism is also recorded by thin intervals of felsic tuff within black silicified siltstone along and below Bowser Lake Group sediments at their western margin. In the northeast, this unit occupies steep fault-

Photo 5. Layered massive basaltic flow and flow breccia. Northwest-facing slope of Todagin Mountain.

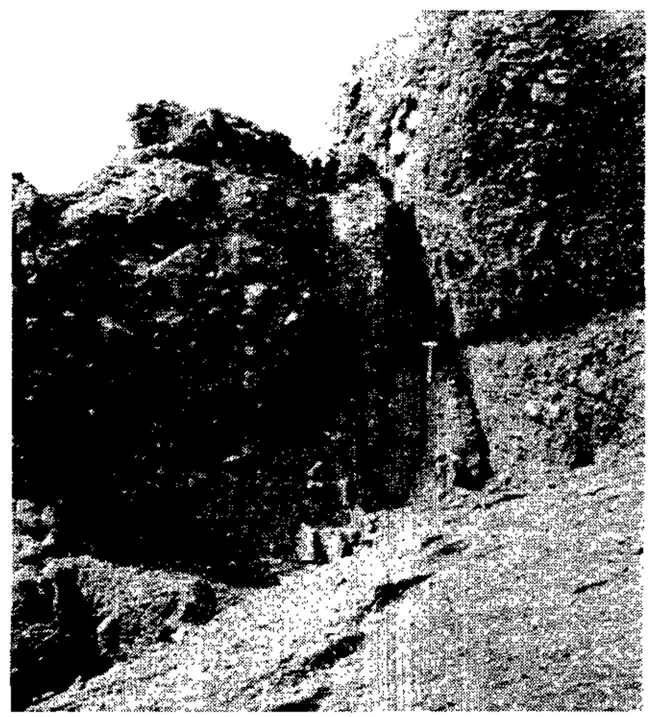

Photo 6. Massive augite-phyric basaltic breccia with clasts of augite-phyric volcanics. Northwest-facing slope of Todagin Mountain.

bounded lenses. To the south it forms an interval, at least several tens of metres thick, between underlying augite-phyric volcanics and overlying Bowser Lake Group chert-pebble conglomerates due west of Todagin Mountain. This unit was assigned to the

Quock Formation of the Spatsizi Group by Evenchick and Green (1990). Although present in many areas along the Bowser contact, the unit appears to be locally faulted out. These rocks are most likely of Pliensbachian age as a potential felsic volcanic source of that age has been mapped to the immediate southwest and is described following.

LOWER JURASSIC STRATIGRAPHY

SOUTHWEST TODAGIN

In contrast to the east and central area described above, the southwest part of the Todagin Plateau is dominated by augite-phyric basalts with lesser amounts of siltstone and volcanic wacke (Figure 3). This area also contains a significant component of rhyolitic volcanic and volcaniclastic rocks.

This region has particular significance as it represents an exceptionally well developed section of the Lower Jurassic volcanic stratigraphy. Throughout this area bedding, flow banding and lithologic contacts consistently strike east-southeast, are steeply to moderately inclined and face toward the southwest. Continuous exposures with well preserved volcanic features are found along a number of secondary creeks that flow across strike.

The base of the section is a mixed interval of mafic volcanic flows and medium to coarse-grained volcanic wackes. Above this is an interval of thick mafic flows, locally interlayered with 2 to 6-metre intervals of bedded feldspathic wacke and siltstone. These are overlain by a 10 to 30-metre section of well developed pillow lavas that are succeeded upward by more than 500 metres of bedded rhyolitic volcanic rocks.

Medium to coarse-grained feldspathic wackes with intermittent intervals of black, bedded siltstone are dominant at the base of the section. Coarse to very coarse volcanic wackes, containing 10 to 20% angular pebble-sized siltstone and occasional rhyolite fragments in a matrix of medium to coarse-grained, massive feldspathic wacke, become a recognizable component near the top of the section. Intervals of siltstone or interbedded siltstone and feldspathic sandstone within the mafic volcanic section commonly contain ammonite fauna which have been used to determine the age of the section.

Augite-phyric basalts form a thick interval of layered massive and pillowed flows in the middle of the section. They begin with several tens of metres of pillows and pillow breccias that are overlain by a series of massive flows from 8 to 15 metres thick. Cores of

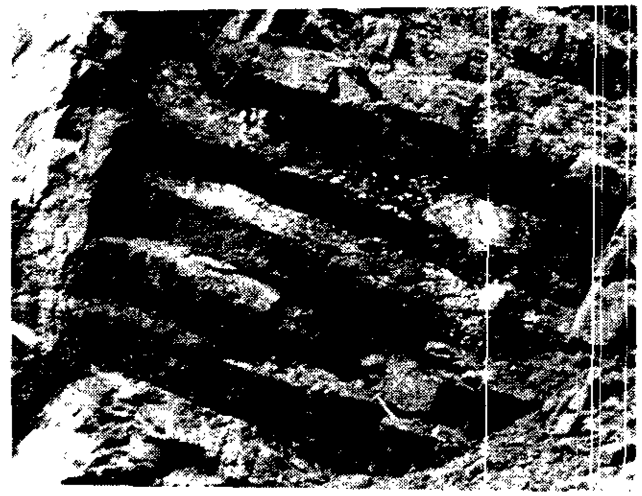

Photo 7. Columnar jointed core in massive augite-phyric volcanic flow within the southwest Todagin section.

many of the flows display well developed columnar joints perpendicular to the flow contacts (Photo 7). Some massive flows are overlain by thinner intervals of pillows and pillow breccias that are overlain, in turn, by 3 to 5-metre intervals of siltstone and sandstone.

Rhyolitic volcanism is first recognized in this section by the appearance of felsic tuff and angular rhyolitic fragments in coarse epiclastic sediments interbedded with the uppermost mafic flows. Coherent rhyolitic volcanic strata first appear as a relatively thick-layered flow above the pillowed mafic volcanic section. Several hundred metres of massive rhyolite at the base of the flow grades upward through a banded zone several metres thick into a 200 to 300-metre

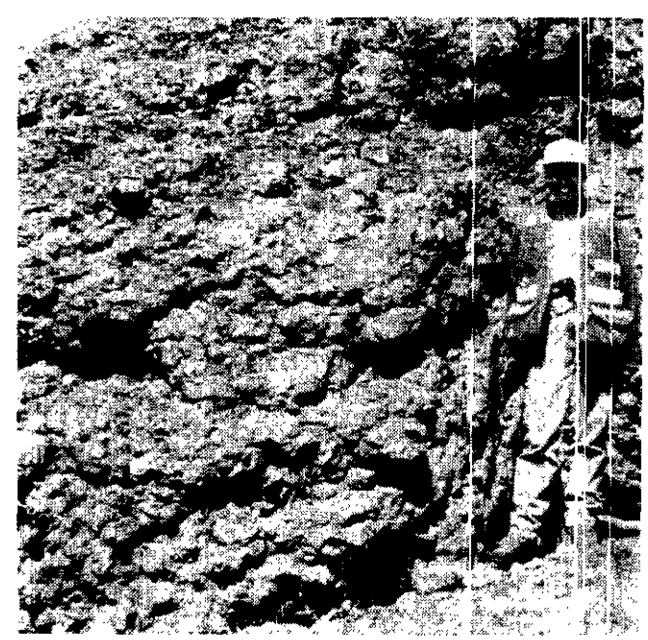

Photo 8. Rhyolite volcanic breccia along the southwestern flank of the Todagin Plateau.

interval of autoclastic breccia (Photo 8). The orientation of flow banding is parallel to the contact between the massive flow and the flow-top breccia and is consistent with that in the underlying mafic volcanic and sedimentary rocks.

Weathered exposures of rhyolite are usually pink in colour, but buff-white to tan-brown varieties are also common. The rocks are aphanitic and usually aphyric, but quartz-porphyritic varieties with 1 to 2-millimetre quartz eyes comprising from 1 to 2% of the unit are locally present, but rare. Sanidine microphenocrysts may also be present. Exposures of the unit vary from massive, to banded to brecciated, with occasional intervals of ash-flow tuff.

SOUTH KINASKAN

The south Kinaskan area (Figures 4 and 5) is underlain by a largely undifferentiated sequence of Lower Jurassic basaltic and rhyolitic volcaniclastic and epiclastic rocks that are interbedded with coarse, massive feldspathic wackes and siltstones. Relatively homogeneous sections of basaltic volcanic rocks, with alternating intervals of rhyolitic volcanics of comparable thickness, are exposed along the southwest shore of Kinaskan Lake. This stratigraphic interval is interpreted to be the base of the section in this area and correlative with the basalt-rhyolite section in the southwest Todagin area.

Basaltic volcanic rocks include flow breccias and more common epiclastic sediments. Epiclastic sediments comprise bedded sequences of medium to coarse lithic wacke (Photo 9) that form intervals between the more massive breccias. Laharic and autoclastic breccias are both present, but become less prevalent along the southwest shore of Kinaskan Lake where epiclastic sediments dominate. Angular rhyolitic fragments, from several millimetres to several centimetres across, are a minor to locally appreciable component of the epiclastic rocks. The buff-white rhyolite fragments are easily recognized in these typically dark green to black-weathering exposures.

Rhyolitic epiclastic sediments interbedded with siltstone and massive, coarse feldspathic wackes crop out on the plateau west of the southern end of Kinaskan Lake. Beds vary from metres to tens of metres thick. Wackes are in general massive and buff coloured, while siltstones are black and laminated to thinly bedded. Intervals of coarse, buff-white to light grey rhyolite-dominated epiclastic rocks comprise sequences which are bedded on a centimetre scale (Photo 10). Rhyolitic sediments overlying siltstone typically contain 5 to 10% rip-up clasts at their base (Photo 11). These are tabular clasts, oriented parallel to bedding, that decrease in size and frequency upward over distances of 1 to 2 metres. These beds strike east and northeast and face southwards with moderate dips.

Photo 9. Coarse-bedded basaltic lithic wackes, west shoreline of Kinaskan Lake. Note buff white rhyolite fragments.

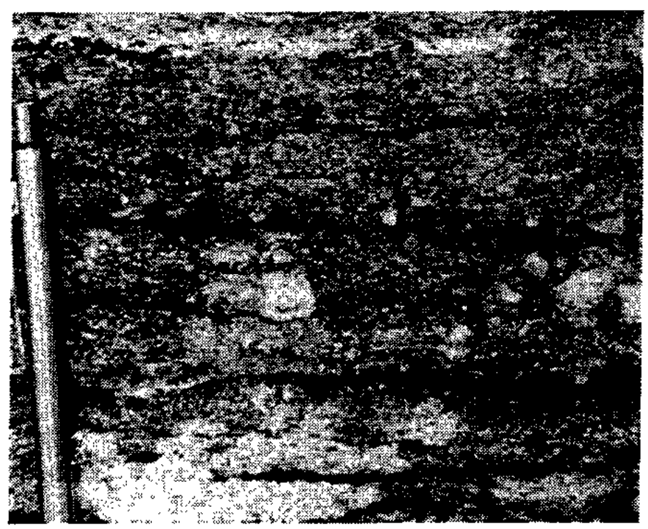

Photo 10. Bedded epiclastic rhyolitic rocks on plateau west of Kinaskan Lake.

Basaltic-pebble conglomerates that underlie Bowser Lake Group sediments form a relatively continuous unit in the southeast corner of the Kinaskan map area. They also occur in isolated

Photo 11. Siltstone rip-up clast at base of rhyolitic epiclastic interval overlying laminated black siltstone, on plateau west of Kinaskan Lake.

Photo 12. Black, thickly bedded basaltic conglomerate, southeast Kinaskan Lake area.

intervals within the undifferentiated sequence to the north. The conglomeratic unit appears to represent the highest stratigraphic interval of the Lower Jurassic volcanic sequence in this area. The unit is dark green to black weathering and locally bedded on a metre scale (Photo 12). Rounded to subrounded lithic fragments of felsic volcaniclastic material are a minor though common constituent of the unit. These are subrounded, pebble to cobble-sized clasts that are more resistant and lighter coloured than the matrix and are concentrated within the bottom 5 to 10 centimetres of individual beds. Graded bedding indicates that this gently dipping sequence is right way up.

NORTH KINASKAN

Massive, banded and tuffaceous rhyolitic volcanic rocks occur locally in the north Kinaskan area, but are volumetrically minor. Andesitic vocaniclastics are also locally cut by fine-grained quartz-phyric felsic dikes and are probably related to rhyolitic volcanic rocks. These rhyolitic volcanics are locally overlain by bedded sequences of massive fossiliferous limestone, limy grit and lime muds at least several hundred metres thick. Fossils from this unit suggest an early Pliensbachian age (Tipper, 1995; GSC Loc. No. C-208834).

CENTRAL KINASKAN

Lower Jurassic volcanic rocks in the central Kiniskan area are relatively minor but significant. Several kilometres due north of the centre of the Groat stock an isolated section of basaltic volcanic flows and epiclastic rocks rests unconformably on medium to fine-grained bedded wackes, interpreted to be part of the Upper Triassic sedimentary sequence. Other evidence of Jurassic volcanism in this area includes a 10 metre wide augite-phyric mafic sill in bedded siltstone north of the Groat stock in Groat Creek

AGE AND CORRELATION OF JURASSIC VOLCANIC ROCKS

The age of this basalt-rhyolite volcanic succession is constrained by both published biostratigraphic data for the area and newly obtained fossil data. Pliensbachian ages have been previously reported for the Lower Jurassic volcanic suite in two separate localities. One of these is near the top of the volcanic succession west of Kinaskan Lake (Evenchick, 1991) and the second is in the southwest Todagin area (Newell and Peatfield, in press).

Two of three macrofossil collections recovered from bedded siltstone-sandstone intervals within the basaltic portion of the southwest Todagin section contained diagnostic fauna (Tipper, 1995). One sample (GSC Loc. No. C-208817) contained several poorly preserved ammonites suggesting several genera indicative of possibly a late Pliensbachian age. Another sample (GSC Loc. No. C-208815) contained well preserved early Pliensbachian fossils. Fossiliferous bedded limestone sequences, locally associated with rhyolitic volcanic rocks in the north Kinaskan area, contain both bivalves and ammonites that are also interpreted to be of early Pliensbachian age (Tipper, 1995; GSC Loc. No. C-208834).

The wider ranging Lower Jurassic *Weyla* bivalve was identified (Tipper, 1995) in two samples collected from limy units at the top of the Lower Jurassic section in both the central Todagin and south Kinaskan areas. The central Todagin sample was from light to dark grey, gritty limestone that forms a laterally restricted interval, possibly 10 to 20 metres thick, between augite-phyric basalt and Spatsizi Group sediments, west of Todagin Mountain (GSC Loc. No. C-208816). The south Kinaskan sample was collected from a limy interval within the basaltic conglomerate unit east of Kinaskan Lake (GSC Loc. No. C-208818).

Isotopic dating of rhyolite from the southwest Todagin map area by U-Pb zircon methods is currently in progress at the University of British Columbia. Processing of the sample recovered some zircons, but they are limited in both size and quantity (R.M. Friedman, written communication, 1995). Analyses are pending.

The early Pliensbachian age of this sequence, combined with the bimodal basalt-rhyolite character of the volcanic rocks and their tectonostratigraphic position immediately below the Bowser Lake Group, suggests that they are correlative with the Cold Fish volcanics (Thorkelson, 1992). The type area of these rocks is along the northeastern margin of the Bowser Basin, 50 kilometres due east of the Todagin map area. Both biostratigraphic and isotopic data constrain Cold Fish volcanics at early Pliensbachian (Thorkelson, 1992). Similar bimodal Lower Jurassic volcanic rocks are also present in the Eskay Creek area to the southwest (Britton *et al.*, 1989; Bartsch, 1992, 1993), indicating that bimodal volcanism was widespread in this part of Stikinia during lower Pliensbachian time.

MIDDLE JURASSIC STRATIGRAPHY

BOWSER LAKE GROUP, BASAL ASHMAN FORMATION

Middle Jurassic (Bathonian to early Oxfordian) marine clastic sedimentary rocks (Gabrielse and Tipper, 1984; Poulton *et al.*, 1991) of the Bowser Lake Group that crop out along the southern margin of the map area are assigned to the basal Ashman Formation, comprising siltstone, chert-pebble conglomerate and sandstone (Evenchick and Thorkelson, 1993). Sedimentalogical studies indicate that Bowser Lake rocks become progressively younger to the south and that deposition was from the north into the tectonically active northern margin of the Bowser Basin (Ricketts, 1990; Ricketts and Evenchick, 1991; Green, 1991).

EAST AND CENTRAL TODAGIN

In the east and central Todagin area, interbedded chert-pebble to cobble conglomerates and sandstone form prominent isolated ridges or spurs surrounded by recessive and generally poorly exposed intervals of bedded siltstone. In addition to the prominent east and southeast-trending faults, the area is further dissected by a series of north to northwest-trending, high-angle cross faults that further disrupt the stratigraphy. Chert-pebble and cobble conglomerate with thinner interbeds of sandstone is the dominant lithology in the Todagin Mountain area.

Chert-pebble conglomerates consist of subrounded 0.5 to 3-centimetre, generally light and dark grey or green chert pebbles in a tan-brown to grey sandstone matrix. Massive layers contain 40 to 60% clasts. Bedded exposures comprise layers defined by alternating beds of massive conglomerate tens of centimetres to several metres thick with thinner, massive sandstone interbeds. Bedding in some outcrops is defined by an upward reduction in both size and abundance of chert clasts, repeated over thicknesses of 5 to 15 centimetres.

SOUTHWEST TODAGIN

Middle Jurassic Bowser Lake Group rocks in the southwest Todagin section are dominated by bedded siltstone with intermittent, thinner intervals of bedded chert-pebble to cobble conglomerate and sandstone (Photo 13). Black, thinly laminated siltstone, with lesser buff-white centimetre-thick sandstone interbeds form homogeneous bedded sections from 600 to 800 metres thick. Conglomerate-sandstone intervals occur as both laterally discontinuous lenses and continuous beds. Lenses are several metres thick and taper laterally over distances of several tens of metres to several hundred metres. Laterally continuous beds are from 100 to 200 metres thick.

Bowser Lake Group rocks in this area form a homoclinal sequence with bedding orientation consistently east-southeast and tops to the southwest. Folding and shearing of Quock Formation sediments immediately below Bowser Lake Group rocks in this area suggest that the basal contact of the Bowser is faulted.

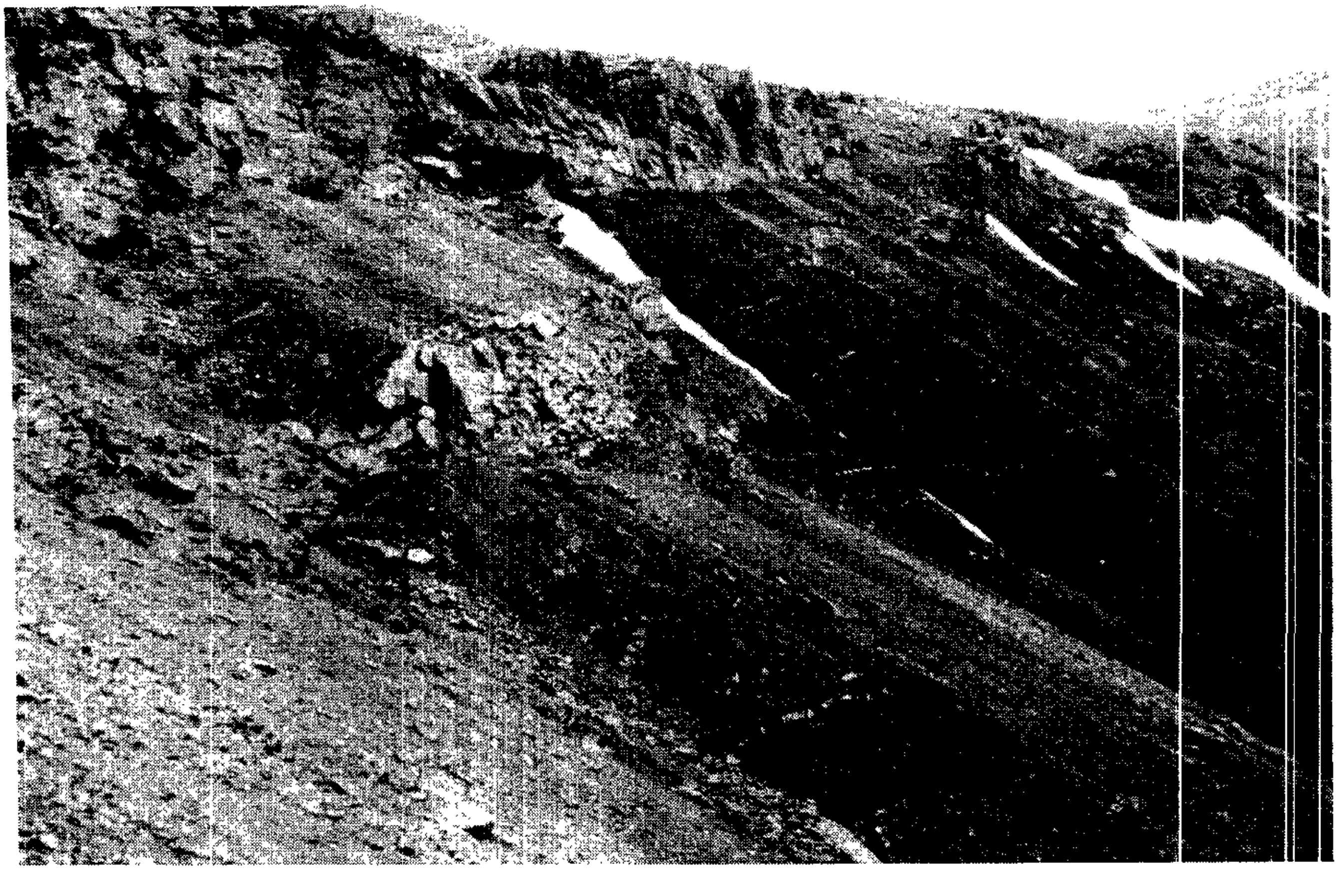

Photo 13. Lenses of interbedded chert-pebble to cobble conglomerate and sandstone in bedded black siltstone. Viewed toward the west along northeast-facing valley wall, southwest Todagin section.

MIDDLE JURASSIC INTRUSIVE ROCKS

Hornblende Quartz Diorite to Monzonite

Hornblende quartz diorite to monzonite occurs as a suite of high-level, elongate stocks and dikes throughout the map area. The largest intrusions of this type include the Red stock and the Groat pluton which are both compositionally variable, equigranular to porphyritic southwest-trending elongate bodies. The Red stock which hosts the Red-Chris deposit, intrudes massive volcanic wackes, siltstone and possibly augite-porphyritic basalt in the southwestern area of the Todagin Plateau (Figure 3 and 4). Abundant related dikes, or possibly plugs, are present north of the Red stock in this area.

The intrusions are compositionally variable, ranging from quartz diorite to quartz monzodiorite. They are characteristically medium grained, equigranular to porphyritic and weather a buff-white to light grey colour. Smaller dikes are usually porphyritic with distinctive medium to coarse-grained hornblende and plagioclase phenocrysts randomly oriented in a light grey, aphanitic groundmass. Plagioclase is the dominant phenocryst phase, occurring as 2 to 5-millimetre subhedral tabular grains comprising from 30 to 45 modal percent of the unit. Hornblende phenocrysts are less abundant, comprising from 6 to 12 modal percent; they are usually of similar grain size, but locally form coarser tabular phenocrysts up to 1 centimetre long and are a diagnostic feature of the unit. The groundmass mineralogy comprises micro-crystaline, anhedral, granular quartz and feldspar.

Some dikes, generally on the order of several metres wide, are typically crowded plagioclase porphyries and, in some instances, contain up to 10% quartz as a phenocryst phase. This suggests that they represent slightly more evolved, differentiated phases of the larger stocks.

The Groat pluton intrudes fine-grained clastic and pelagic sedimentary rocks in the central part of Kinaskan Lake area (Figures 4 and 5).

The contacts between the pluton and its country rocks, on surface and in drill core, are characterized by wide sheeted zones of densely packed dikes or sills with screens of country rock, but correlation between holes is poor, as are orientation data (McInnis, 1981; Mehner, 1991). Detailed structural mapping would be needed to determine whether the pluton is a large sill or a discordant plug.

The elongate shape of the Groat pluton does not appear to be primary. Its overall length is increased by dextral offset along two northeast-trending strike-slip faults. These faults are probably a western extension of the regionally significant Ealue Lake fault. The southern fault zone is at least 100 metres wide and is marked by intensely fractured cataclastic zones, with veins of pseudotachylite. Slickenlines (grooves, epidote and chlorite mineral fibres), slickensteps, and the offset of the pluton contact indicate dextral offset along both faults. The mean strike and dip of 25 fracture measurements (mainly from Groat Creek valley, where the two faults seem to merge) is 093°/90° and the mean of 16 slickenline lineations is 06° towards 273°, indicating strike-slip movement. Minor related faults are seen in the 1990 core and marked by small offsets of the pluton contact.

Preliminary U-Pb zircon isotopic data for two intrusions to the north of the Red stock suggest that this suite is Early Jurassic (Friedman, 1995). A small plug or dike of plagioclase-hornblende-quartz-porphyritic quartz diorite on the north flank of the Todagin Plateau (sample CAS94-307; Figure 1) returned an age of 198.6±4.9 Ma. A quartz diorite to monzodiorite stock at the eastern margin of the Todagin Plateau (sample CAS94-215) returned an age 197.9+1.8/-3.2 Ma. An attempt at isotopically dating the Red stock was unsuccessful due to the intensity of alteration affecting the intrusion. Based on the close proximity, comparable geometry and styles of both alteration and mineralization, as well as the obvious textural similarities to less altered, dated rocks, it is assigned a similar age and regarded as an altered equivalent.

Isotopic dating of the Groat stock by hornblende K-Ar analysis (Schmitt, 1977) suggest a cooling age of 195±8 Ma, which is in agreement with the suggested magmatic age of the Red stock and related intrusions. A sample of equigranular hornblende quartz monzonite was collected from the southeastern part of the pluton for radiometric dating. In this sample, euhedral andesine laths are poikilitically enclosed by larger hornblende and orthoclase grains. Initial processing of the sample indicates that it contains sufficient zircon of suitable quality to provide a possible age date (R.M. Friedman, written communication, 1995).

Andesitic volcaniclastic rocks in the north Kinaskan area are locally intruded by several small and widely separated plugs or dikes of medium-grained hornblende diorite. These are interpreted to be coeval with Early Jurassic intrusions to the south and east, which are mineralogically and texturally similar. Intrusive rocks in this area are volumetrically minor, considerably less extensive than those mapped farther to the southwest.

All intrusions coincide to some degree with areas of ankeritic alteration, with or without development of quartz stockwork mineralization. The Red stock is by far the most intensely affected.

PYROXENE DIORITE

Pyroxene diorite forms a distinct, northwest-trending, elongate pluton, from 0.5 to 1 kilometre wide and over 4 kilometres long, on the southwest end of the Todagin Plateau (Figure 3). It also crops out near the summit of a north-trending ridge between Kinaskan Lake and Highway 37. Continuity of the unit across the Todagin Creek valley is conjectural.

The unit weathers a dull grey to buff white. It is typically medium grained, equigranular and isotropic with plagioclase dominating over pyroxene. Coarse to medium-grained varitextured phases are locally present, but are a minor component.

The age of this unit is not yet defined isotopically. The tabular geometry and orientation of the pluton, concordant with the Lower Jurassic volcanic stratigraphy to the immediate southwest, suggests that it may be a coeval sill-like body related to the augite-phyric basaltic unit. Contact relationships are poorly exposed.

A sample of the medium to coarse-grained varitextured phase of the unit was collected for U-Pb isotopic analysis. Initial processing of the sample reveals that zircon is absent but titanite is present in sufficient quantities to provide a possible date (R.M. Friedman, written communication, 1995).

ECONOMIC GEOLOGY

Chalcopyrite as disseminations in fracture-controlled quartz vein stockworks is the dominant style of mineralization throughout the map area. It appears to be related to high-level, subvolcanic dikes and stocks which intrude volcanic and sedimentary rocks. In almost all instances copper mineralization is dominant, and associated with elevated concentrations of gold and silver. Two distinct styles of quartz stockwork mineralization are distinguished on the basis of both alteration type and associated lithologies.

The first is characterized by intense quartz-ankerite-sericite alteration in zones of quartz stockwork associated with hornblende quartz diorite to monzonite intrusions. These are dominant in the southern half of the map area and are associated with broad peripheral ankerite alteration halos producing distinctive tan to orange-brown stain zones. Sulphide content in this type is generally low. The Red-Chris deposit is the most significant deposit of this type and has been described previously (Ash *et al.*, 1995). A number of comparable, though smaller showings with similar styles of mineralization are associated with the Groat pluton (Figure 6). These include the GJ/Groat (MINFILE No. 104G-034), Sun (104G-087), Wolf (104G-045) and the Goat Hide (104G-086).

The second type, characterized by finely disseminated pyrite±chalcopyrite in silicified felsic (rhyolitic) dikes and stocks and their immediate hostrocks, is the dominant style of mineralization in the northern half of the project area. It forms impressive, rusty brown, iron oxide stain zones. The felsic rocks generally intrude andesitic breccias and are surrounded by epidote alteration halos with localized patches of pyrite commonly developed. Ankerite alteration or veining has not been identified. Examples include the Edon (104H-004), Coyote (104H-012), Al (104G-044), Castle (104G-076), and possibly much of the Rose of Klappan group of showings (Figure 6). The stain zone associated with the Edon showing (Figure 6) is an excellent example of this type and can be easily seen from Highway 37. The most accessible showing is the Coyote, located at the west end of Ealue Lake along the Ealue Lake road (Figure 6). Rusty brown silicified and pyritized felsite is exposed in a number of roadside outcrops roughly 6 kilometres east of Highway 37.

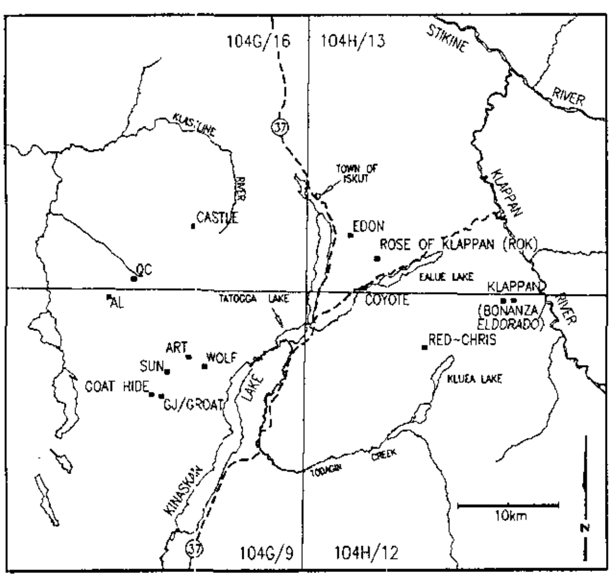

Figure 6. Mineral occurrences in the Tatogga Lake map area.

ANKERITE ALTERATION

Carbonate alteration as ankerite or some variety of iron magnesite is a clearly recognizable feature that is concentrated within and close to Early Jurassic plagioclase-hornblende-phyric intrusions throughout the study area (Figures 3 and 4). The extent and intensity of alteration is, however, highly variable. Zones of iron carbonate alteration range from several tens of metres to over a kilometre in lateral extent. The broadest area of alteration is north of the Red stock which is itself intensely affected. The concentration of hornblende quartz diorite dikes to the north of the Red stock is the likely cause. Areas of ankerite alteration shown to the north and west of the Red stock are surrounded by broad areas of moderate carbonatization. In contrast, areas of alteration in the west central area of the Todagin plateau are usually localized and lack broader haloes of decreasing alteration intensity. Similar alteration is found within and near the Groat pluton, but is much more localized. Alteration does not affect younger, Middle Jurassic Bowser Lake sediments to the south and no ankerite was found associated with the elongate pyroxene diorite, sill-like intrusion in the southwest Todagin area.

The distribution of ankerite alteration as shown on Figures 3 and 4, is indicated where seen in outcrop only. No attempt has been made to correlate between occurrences. Radarsat and other satellite data will be used in an attempt to accurately determine the distribution and extent of ankerite alteration in the area. The Tatogga Lake project area has been selected by the Canadian Space Agency as a site to study the usefulness of satellite data in mountainous terrains. In conjunction with Vern Singhroy of the agency and Eric Grunsky of the British Columbia Geological Survey Branch, landsat thematic mapper and radarsat data will be applied to study spectral responses and structural attributes such as faults.

Ankerite alteration zones are identified by areas of distinctive tan to orange-brown limonitic weathering. They are characterized by discrete veins or broadly fractured zones permeated by ankerite, with associated pervasive carbonatization of surrounding hostrocks. Intense alteration zones are typically cored by carbonate veins 1 to 4 centimetres wide or zones of vein breccia generally from one to several metres wide.

Different lithologies are altered to varying degrees as a function of composition (reactivity with a CO_2 rich fluid) and texture (porosity). Mafic volcanic rocks are the most intensely altered and massive wackes to a slightly lesser degree. Siltstones are the least affected lithology, presumably because of their low porosity, maintaining their primary black colour, even in zones of ankerite flooding. This feature is particularly helpful in distinguishing between mafic volcanic rocks and medium-grained massive wackes in areas of intense alteration. Usually where areas of siltstone have been affected by ankerite flooding, breccias are developed with 0.5 to 1-centimetre angular fragments of black siltstone randomly oriented in a tan to orange-brown carbonate matrix.

Concentrations of pyrite as disseminations or clots are occasionally seen within ankerite-altered sediments and volcanics. Assays from these pyritiferous rocks returned no elevated concentrations of precious or base metals. Copper-gold mineralization appears to be preferentially concentrated within and marginal to the intrusive rocks.

A variety of documented mineral occurrences were examined in the course of mapping in the area. Several of these, including the Red-Chris, GJ and Klappan properties are discussed below.

RED-CHRIS DEPOSIT

The Red-Chris is a porphyry copper-gold deposit hosted by the Red stock, an east-northeast elongate intrusive body of pervasively quartz-sericite-ankerite-pyrite (phyllic) altered, plagioclase hornblende porphyry (Panteleyev, 1973, 1975; Leitch and Elliott, 1976; Schink, 1977; Newell and Peatfield, in press). Chalcopyrite and localized concentrations of bornite are associated with zones of quartz stockwork and sheeted quartz veining. The quartz stockwork forms a steeply dipping, high-grade core zone associated with intense and pervasive carbonatization that is surrounded by, and gradational into, barren to weakly mineralized, phyllic (quartz-sericite-ankerite-pyrite) altered host stock. Quartz stockwork zones dip steeply to the north and parallel the long axis of the stock. A detailed description of this deposit, describing styles of alteration and mineralization has been published previously (Ash *et al.*, 1995). Here we summarize significant results from the 1995 drilling program.

In 1994 and 1995 this deposit was the focus of an intensive exploration drilling program by American Bullion Minerals Ltd. During 1994, 21 417 metres was drilled in 58 holes which outlined a potential bulk-tonnage mineable reserve of 157 million tonnes grading 0.5% Cu and 0.4 g/t Au. From early May to mid-November, 1995, a total of 36 830 metres of drilling was completed in 115 holes, focusing primarily on delineating reserves in the Main zone, and to a lesser extent in the East zone. An 800-metre 60° drill hole on the East zone established vertical continuity to over 700 metres. Exploratory drilling to the west of the Main zone, to test induced polarization anomalies in the area of the East and West gullies, was successful in identifying two new zones of stockwork copper-gold mineralization. These are referred to as the Gully and Far West zones or collectively as the Yellow Chris.

Drilling on the Main and East zones was successful in increasing the mineral inventory by close to 30%. Recently released preliminary reserve estimates (George Cross News Letter, November 22, No.224) indicate current geological reserves of 220 million tonnes grading 0.5% Cu and 0.4 g/t Au in the Main and East zones, with potential for an additional 80 million tonnes in the newly discovered Yellow zone. More detailed reserve estimates have not yet been published.

The Gully zone is an east-trending area of quartz stockwork copper-gold mineralization situated between the East and West gullies. A total of 36 holes outlined two parallel, subvertical intervals of copper-gold mineralization to a depth of roughly 300 metres. These zones are separated by an unmineralized interval of gypsum stockwork, most likely along a later fault. Both mineralized intervals have been tested by widely spaced drilling over a strike length of 400 to 500 metres and widths of 200 to 300 metres and they remain open both laterally and vertically.

Roughly two-thirds of the mineralization is hosted by altered Red stock. The remainder is contained within a contact zone of sheeted Red stock with screens of the feldspathic wacke country rock.

Depth to mineralization in this area is variable. The mineralized zone is blanketed by a relatively flat-lying interval of unconsolidated breccia from several metres to several tens of metres thick. The breccia is coarse to pebbly, consisting of 0.3 to 2-centimetre, subangular to angular fragments of altered Red stock. The local occurrence of bornite within the breccia suggest part of this cap may be ore grade. Current theories on the origin of the breccia invoke leaching of gypsum from a pre-existing stockwork by meteoric waters.

Typical assays in the southern part of the Gully zone range from 0.3 % Cu and 0.3 g/t Au over intervals of 15 to 300 metres (J.D. Blanchflower, personal communication, 1995). Occasional high-grade inter-sections are also encountered; an 18.3-metre interval in hole 95-168 has an average grade of 1.5% Cu and 3.3 g/t Au (including 3 metres grading at 2.47 % Cu and 5.9 g/t Au). Mineralized intervals in the northern part of the Gully zone are narrower,. grades vary from 0.15 to 0.35% copper with corresponding gold values in the range of 0.20 to 0.40 g/t Au.

The Far West zone follows two east-trending vertical structures. Current dimensions, defined by thirteen holes to an average depth of 300 metres, indicate a mineralized zone 300 metres wide by 500

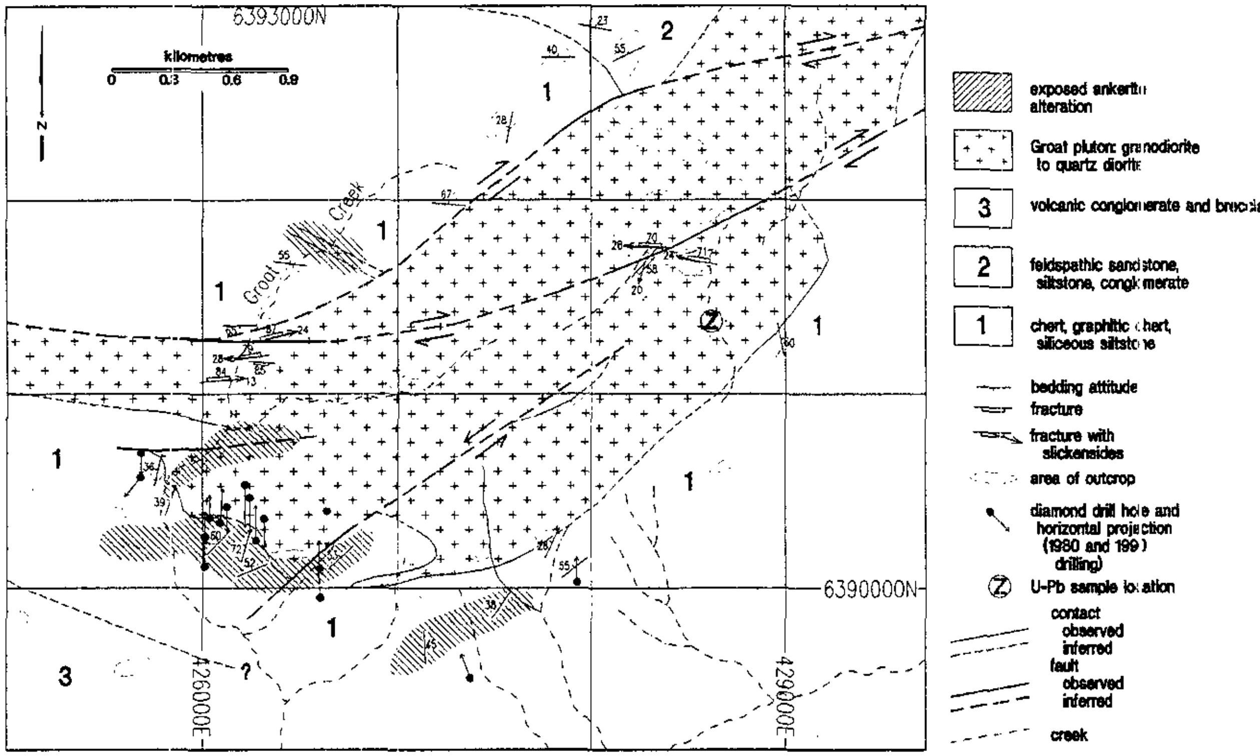

Figure 7. Geology of the Groat property, central Kinaskan Lake map area.

metres long, open both along strike and vertically. As in the Gully zone, mineralization is hosted by both Red stock and volcanic sediments. Grades are from 0.2 to 0.4% Cu with corresponding gold values in the range of 0.2 to greater than 0.4 g/t Au.

GJ/GROAT PROPERTY

The GJ/Groat property is located near the southwestern end of the Groat pluton in the central Kinaskan Lake area (Figures 4 and 7). The pluton underlies a fairly level, grass-covered alpine plateau. Exposure is poor except where the plateau is cut by deep creek drainages. Mineralization and alteration are similar to the Red-Chris deposit but are less extensive. Several companies have explored around the southwestern margin of the pluton since the mid-1960s (Mehner, 1991, provides a summary) with most work centred on the GJ claim. Drilling between 1970 and 1990 totaled 8944 metres; core from 1980 and 1990 is stored on the property. Most of the pluton was mapped as part of the regional mapping project, and a day was spent examining the well preserved 1990 core.

The pluton intrudes Upper Triassic fine-grained clastic and pelagic sedimentary rocks consisting of bedded sandstone, siliceous siltstone, chert and graphitic chert. Volcanic siltstone, sandstone, and conglomerate overlie these siliceous sediments to the north. To the south are coarse andesite and basalt-derived conglomerates. The country rocks are cut by several coarsely augite-phyric mafic sills which, in turn, are cut by Groat dikes.

The Groat deposit is hosted by siliceous sediments and by the southwestern part of the pluton. The most significant mineralized zones (chalcopyrite in quartz stockwork) were drilled by Amoco Canada Petroleum Co. Ltd. in 1970. Five holes were drilled from one set-up at the base of Groat Creek (one vertical and four inclined to the four points of the compass). Intersections in these holes were typically approximately 145 metres averaging 0.25% Cu, 0.5 g/t Au, and 3 g/t Ag (Mehner, 1991). Later drilling by other companies attempted to extend this zone; Texasgulf Canada Ltd. tested alteration and mineralization to the west, on the Goat Hide claim (Forsythe *et al.*, 1977); some holes intersected mineralized intervals, but continuity was not established (J. M. Newell, personal communication, 1995).

The most prominent alteration types on the Groat property are ankerite flooding and silicification. Several zones of intense ankerite alteration and brecciation, 10 to 30 metres wide, cross the deposit

TABLE 1.
METAL ABUNDANCES OF MINERALIZED CORE SAMPLES FROM THE GROAT AND KLAPPAN PROPERTIES

Sample Number	Rock Type	*Au	Ag	Cu	*Mo	Pb	Zn	*As	*Sb	*Cs	Ni	*Co	Cd	V	Cr*
		ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Detection Limit	2	0 3	1	1	3	1	0.5	0.1	1	1	1	0.2	1	1
Groat Core															
GR90-1-22.5 to 25 m	chert, quartz-ankerite-sulphide veined	54	1.1	345	62	19	571	15	3	<1	109	7	13.8	283	230
GR90-1-28 to 287.5 m	brecciated & ankerite-flooded chert	86	2.3	398	18	109	6205	48	2.3	<1	31	6	147	45	250
GR90-1-45 m	silicified siltstone, pyrite veinlets	85	<0.3	359	5	4	34	3.2	0.9	<1	19	10	0.6	25	170
GR90-1-67 to 68 m	chert, fracture-filling pyrite	83	0.6	662	4	8	53	5	1.6	<1	13	7	1.4	25	180
GR90-1-87 to 88 m	monzodiorite, minor quartz stockwork	893	1.7	3536	10	< 3	49	2.9	1.6	4	11	28	<0.2	105	44
GR90-2-35 to 35.5 m	monzodiorite, minor chalcopyrite	110	0.4	412	4	< 3	31	<0.5	1.5	2	4	15	0.4	121	43
GR90-2-57 m	monzodiorite minor qtz veining	372	0.7	1581	11	< 3	33	5.2	2.6	<1	5	18	0.5	148	35
GR90-2-75 to 77 m	monzodiorite, minor chalcopyrite	140	1.1	598	<1	< 3	49	3.5	1.8	2	7	17	0.7	162	32
GR90-2-104 to 116 m	recrystalized chert, fracture-filling pyrite	10	1.1	218	64	12	48	47	13	<1	34	7	0.7	134	210
Klappan Core															
K80-2-63.6m	quartz vein in altered augite porphyry	143	0.7	327	10	7	180	13	4.4	<1	83	25	0.9	54	220
K80-2-94.0m	chlorite-altered augite porphyry	155	1.2	478	13	< 3	128	160	6.1	5	94	110	0.6	99	270
K80-2-200.7m	andesitic brx. chlorite+epidote+pyrite	84	<0.3	27	<1	< 3	69	4.4	2	3	5	29	0.6	135	75
K80-3-7.3m	augite porph. basalt : calcite+pyrite	11	0.4	60	<1	< 3	47	2.1	3.1	7	45	25	0.6	99	240
K80-4-51.6m	augite porph. basalt : calcite+pyrite	500	2.5	1361	<1	< 3	54	130	11	2	191	42	1	64	570

Elements with an asterisk were assayed using instrumental neutron activation (INAA) by ACME Analytical Laboratories Ltd.
Remaining elements were analyzed using inductively coupled plasma emission spectroscopy (ICP) by Activation Laboratories Ltd.

area from east to west (Figure 6). Peripheral to these zones, the pluton and country rock are cut by abundant discrete veins of ankerite and calcite. This carbonate alteration was previously interpreted as pervasive potassium feldspar alteration (McInnis, 1981; Mehner, 1991). Minor quartz stockwork is present throughout the 1991 core and some sedimentary (or volcanic?) units appear to be totally silicified, typically being logged as quartzite. Due to the amount of chert and siliceous siltstone in the Groat country rocks, much of the silica may be locally derived, and "silicified rocks" may be recrystallized chert. Thick zones of quartz stockwork, as described in the Amoco core, were not identified away from the main deposit area. Weak phyllic to argillic alteration appears to be fairly common throughout the intrusive rocks in the deposit area.

Mineralization consists of pyrite and chalcopyrite in stringers, disseminations and quartz and quartz-carbonate veins. Sphalerite and galena are present locally. Results from several assay samples suggest that gold and copper values are higher in the pluton than in its country rocks (Table 1). Mehner (1991) noted a positive correlation between copper, gold, and silver throughout the deposit.

Several similarities between Groat and Red-Chris deposits are evident, despite the apparent difference in their size. These include styles of both alteration (notably ankerite and quartz veining) and mineralization types, as well as their association with coeval and mineralogically similar plutons.

KLAPPAN PROPERTY

The Klappan property is located just off the eastern edge of the study area (Figure 6), west of the Klappan River in a low-lying, tree-covered region with very limited exposure. The claim group, centred on the Eldorado and Bonanza claims, was staked by Texasgulf Canada Ltd. in 1975 in the course of its exploration around the Red-Chris deposit. Esso Minerals Canada optioned the claims and drilled four diamond-drill holes on an induced polarization anomaly (Everett, 1981). In 1995 Homestake Canada Inc. optioned the claims (current property ownership is 55% Homestake Canada Inc. and 45% Falconbridge Ltd.). During August of 1995, Homestake carried out a limited soil and silt sampling program over the property and conducted a brief examination of the 1980 trenches and drill core. The following property description is based on a one-day examination of the drill core, stored on the property, and rare outcrops in the grid area.

Mafic volcanic rocks are exposed in outcrops in the northern part of the claim group and are seen in core with felsic plutonic rocks. The southeastern part of the property is underlain by sediments of the Bowser Lake Group, probably across a fault (as at Red-Chris to the southwest). The most abundant lithology in core and outcrop is augite-phyric basalt. Euhedral augite phenocrysts, 2 to 10 millimetres across, make up 10 to 40% of the rock. They are variably altered to chlorite, often preserving good concentric zoning, and are set in a black to dark green, aphanitic matrix which locally contains calcite or chlorite-filled amygdules.

Massive andesitic breccias crop out in the northwest part of the grid and are below augite basalt in hole K80-2. The breccias consist of angular, feldspar-phyric andesite clasts up to 10 centimetres across, supported in a dark, aphanitic matrix. This unit is similar to breccias described in the northwest Todagin area.

These units are cut by felsic intrusions, seen in drill holes 3 and 4 but not in outcrop. The bottom 17 metres of hole K80-3 is a crowded feldspar porphyry, with 50%, 4 to 8-millimetre feldspar phenocrysts and 10% smaller hornblende phenocrysts. The bottom 30 metres of hole K80-4 intersected fine to medium-grained equigranular granodiorite which appears to be in intrusive contact with augite porphyry.

Alteration and mineralization are intermittent through the core. The volcanic rocks are affected by pervasive but variable chlorite±epidote±pyrite alteration. Locally, epidote and pyrite preferentially replace clasts in the breccia and phenocrysts in the augite porphyry. Spotty potassium feldspar-sericite-calcite alteration was also noted in augite porphyry, in the equigranular granodiorite, and is strong in the crowded feldspar porphyry. Pyrite is disseminated throughout the core and is present in veins, but chalcopyrite is mainly restricted to quartz-pyrite veins. Quartz veins up to 4 centimetres wide are the most common, comprising up to 40% of the core over some 1 to 2-metre intervals. Pyrite and chalcopyrite, where present, are commonly concentrated near the vein walls. White calcite, ankerite, and adularia(?) veins were also observed. Five grab samples were taken from the core and returned 11 to 500 ppb Au and 27 to 1361 ppm Cu (Table 1).

SUMMARY OF SAMPLE ASSAY DATA

During mapping, areas of alteration and mineralization were routinely sampled and assayed for precious and base metal contents. Small areas of gossan, generally on the order of several metres in lateral extent, occur throughout basaltic volcanic rocks in the southwest Todagin area. Disseminated pyrite in trace to minor amounts is the only identifiable sulphide. Assays of five grab samples from individual gossans returned no anomalous metal abundances. Gossanous areas of rhyolitic volcanic rocks with trace, disseminated sulphides were also identified locally, and in some instances chalcedony quartz veins are present. Samples from these areas of alteration also returned no anomalous values.

Locations of the individual samples and their associated assay results are indicated on open file map 1996-4 (Ash *et al.*, 1996).

CONCLUSIONS

- An early Pliensbachian bimodal basalt-rhyolite volcanic succession is exposed along the northwestern margin of the Bowser Basin in the Tatogga Lake map area.
- On the basis alteration type and lithological association, two distinct styles of porphyry copper-gold mineralization have been recognized in the project area. The first is characterized by intense quartz-ankerite-sericite alteration associated with hornblende quartz diorite to monzonite intrusions surrounded by broad ankerite alteration halos. The second type is confined to the northern half of the project area. It is characterized by pervasive pyritization and silicification associated with rhyolite/felsite dikes and stocks that intrude and epidotize andesite volcaniclastic host rocks. Ankerite is not present in the second type.
- The age of plutonism related to copper-gold mineralization is Early Jurassic (200-198Ma).
- American Bullion Minerals Ltd. has significantly increased potential mineable reserves of copper-gold at the Red-Chris deposit and was also successful in identifying two new zones of copper-gold mineralization.

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