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Noranda, QuebecUNIVERSITY/UNIVERSITÉ Carleton UniversityDEGREE FOR WHICH THESIS WAS PRESENTED/
GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE M.Sc.YEAR THIS DEGREE CONFERRED/ANNÉE D'OBTENTION DE CE DEGRÉ 1980NAME OF SUPERVISOR/NOM DU DIRECTEUR DE THÈSE Dr. Moore

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LA THÈSE A ÉTÉ
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THE GEOLOGIC SETTING OF
THE ALDERMAC COPPER DEPOSIT,
NORANDA, QUEBEC

by

C

ALLYNE DOUGLAS HUNTER, B.Sc.

A thesis submitted to the Faculty of
Graduate Studies in partial fulfillment
of the requirements for the degree of
Master of Science

Department of Geology
Carleton University
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December, 1979

The undersigned hereby recommend to the
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the degree of Master of Science.

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ABSTRACT

This thesis represents a compilation of work and ideas that have been applied to exploration in the Aldermac area from the 1920's to the present. The overall intent of the author is to present a picture of the geology which is compatible with our current knowledge of volcanism and ore genesis.

The Aldermac copper deposit is of proximal volcano-genic type. A number of massive sulphide lenses bore an intimate relationship to a quartz-feldspar porphyritic rhyolite dome, associated fragmentals and laminated, siliceous ("cherty"), volcanic exhalative sediments which probably emanated from this extrusive body.

The stratigraphic succession in the Aldermac area comprises a chemically bimodal suite of intercalated mafic (basaltic to andesitic) and rhyolite flows, pyroclastics and related subvolcanic intrusions. These are cut by gabbro and syenite, intrusions which were attendant to different stages of Archean volcanism and by later, post-Archean diabase dikes. Regional metamorphism attained lower greenschist facies but the rocks lack penetrative deformation.

A salient feature of the geology of the Aldermac terrain is the pervasive silicification of mafic volcanic rocks, either enveloping or stratigraphically below sulphidic zones. Chlorite and sericite are only locally developed in areas of alteration, having a more direct relationship to mineralization. Epidote, calcite and calcium-rich garnet are conspicuous in areas of known mineralization and their recognition is viewed as a future exploration tool.

The geologic setting of the Aldermac deposit is extremely complex and cannot be explained by isoclinal folding; rather it reflects a history of intermittent faulting, and extrusive and intrusive activity, which characterize an active volcanic centre. The Aldermac terrain consists of a number of fault blocks, rotated relative to one another and exhibiting opposing facing directions. The original setting of the area may be visualized as a submarine, graben-like structure or an elongate, trough-shaped caldera like the Mauna Ulu "trench" on the east rift-zone of Kilauea volcano on the island of Hawaii.

Accumulations of sulphide occur in mafic and felsic volcanics alike on both sides of the postulated

volcanic structure. The sulphides are intimately related to both the structural and stratigraphic development of the volcanic pile. It is evident that intense hydrothermal activity must have occurred at one or more stages in order to generate the large number of widely spaced sulphide occurrences.

When the Noranda area is viewed in a historical perspective, Aldermac may prove to be at a very early stage of its exploration potential, perhaps comparable to that of the Amulet area in the late 1920's.

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Frontispiece -- The Aldermac copper deposit underlay low swampy ground near the south contact of a syenite body beneath the area covered by rusty weathering tailings (immediately to the right of centre). Sulphide bearing siliceous tuff, within the large outcrop area directly behind the derelict mine installations, is laterally equivalent to the mined-out orebodies. A large kame-like glacial gravel deposit is prominent beyond and to the right of the old mine. View west from the late diabase dike on Macanda Hill.

CHAPTER I

I. INTRODUCTIONI.1 Location and Pyhsiography of the Aldermac Area

The Aldermac area is situated in the Abitibi belt (Fig. 1), ten miles west-south-west of Rouyn-Noranda, Quebec, within the west central portion of Beauchastel Township (Fig. 1). It is readily accessible from Rouyn via Highway 117 (formerly 50), and the Guertin St Falls gravel pit road, which meets the highway approximately one mile east of the villiage of Arntfield (Fig. 2).

The area studied and presented on the accompanying geologic map (Fig. 3) is largely within Range VI, west central Beauchastel Township. The west and east boundaries are approximately lots 11-12 and 25-26 respectively.

The terrain immediately surrounding the old Aldermac deposit is on the height of land within the township. The rock exposures are prominent and mainly very large, commonly 150-300 m long, and constitute approximately 40% of the total area studied, as shown in Fig. 3. The outcrops are well drained, essentially free of lichen, and are typically separated by well defined areas of low swampy ground characterized by thick alder growth.

Pleistocene glacial gravel and clay deposits are extensive in some areas. Gravels are exposed in a large commer-

Figure 1: Location of the Blake River Group (lightly shaded area) and the Central Noranda area (heavily shaded square) in the Abitibi Greenstone Belt. Volcanic complexes (dashed lines) and shelf to basin transition (lines with hachures towards basin) are outlined, (from Goodwin and Ridler, 1970). The Aldermac area is located by the arrow and the ellipse defines an area within which there has been little deformation.

Figure 2 -- Geology of the Noranda area (from Spence, 1967). The Aldermac area (see Fig. 3) is shown within the rectangle, outlined in red. Note the Beuchastel (B) and Horne Creek (H) faults and excursion stops, some of which are referred to in the text.

cial pit immediately west of the old Aldermac shaft (see Frontispiece). Many fields, the sites of active and past farms, attest to the presence of clay deposits.

I.2 Purpose of the Study

The geology of the Aldermac mine was last described by J.E. Hawley (1948). He dealt very ably but exclusively with the volcanic rocks which hosted the deposit, and the syenite mass to the north. This limitation was reasonable since the sulphides were then considered to be genetically related to this syenite body.

From 1958 to 1962, Consolidated Zinc Corporation worked in the area immediately west of the Aldermac mine (Table 1). The efforts of this company were the first at Aldermac motivated by the concept that massive sulphide deposits like those in the Amulet Hills north of Noranda (Stop 18, Fig. 2) were volcanogenic. People were beginning to believe that the occurrence of such deposits could be predicted. This new exploration philosophy is considered to have been a significant factor in the discovery of the Vauze deposit in 1957, according to J. Boldy (1977).

For many years, H.C. Sakrison has studied volcanic breccias which host massive sulphide deposits. He first introduced me to the Aldermac area in May, 1976. We discussed, among other aspects of the geology, what were then termed bimodal breccia units.¹ He believed these rocks to

¹ comprising siliceous blocks ("rhyolite") in a mafic matrix.

TABLE 1: EXPLORATION AND MINING HISTORY OF THE ALDERMAC AREA

<u>Year (s)</u>	<u>Company or Individual</u>	<u>Prospect or Mine</u>	<u>Nature of Work</u>	<u>Comments</u>
1923	A.A. MacKay Prospector	Aldermac	First staking of Aldermac ground included syenite contact and sulphide stain-gossan zone north of MacKay Lake.	The property was originally staked due to its proximity to the syenite intrusion. The surface mineralized zones were discovered later.
1923	Chance Syndicate	The Chance	Prospecting and trenching on and near this very impressive, locally massive sulphide showing about 1km W.S.W. of MacKay Lake zone.	Refer to Fig. 16 for detailed surface geology.
1923-1925	Towagmac Exploration Company	Aldermac Nos. 1, 2, and 3 deposits	Dip needle survey, trenching and drilling.	No. 1 zone is a chalcopyrite area of fracture controlled sulphides within the main gossan. No. 2 is described as a py + cp rich stratiform lens near the north boundary of this same gossan-stain zone (see Fig. 3 and Fig. 16). No. 3 deposit was detected as a magnetic anomaly in a low swampy area 250 m (800 ft) north of No. 2 (see Frontispiece). It was ultimately developed into the Aldermac mine.
1926-1927	Chance Syndicate Tonopah Canadian Mines Co.	The Chance North Chance	Diamond drilling - 1,273 m (4,000 ft).	Most of the work done was testing the depth of the Chance showing. The maximum vertical test was

(TABLE 1 CONTINUED)

<u>Year (s)</u>	<u>Company or Individual</u>	<u>Prospect or Mine</u>	<u>Nature of Work</u>	<u>Comments</u>
1925-1929	Aldermac Mines Ltd. Towagmac Expl. Co.	Aldermac mine	Three compartment shaft sunk to the 1,125 ft (8th level). Exploration drift ran 330 m (1,000 ft) east on that level. Most of the exploratory and development work was carried on at this level, and over 1,000 m (3,300 ft) of drifting was done up to October, 1929.	100 m (approx. 300 ft) below surface. In 1927, Noranda Mines Ltd. took an option on the property and the shaft was deepened from the 500 ft level to the 1,125 ft level. Work was discontinued in October, 1929. The diabase contacts were drilled tested from the 8th level (see Fig. 20).
1931	Aldermac Mines Ltd.	Aldermac mine	A 223 tonnes (250 tons) per day mill was constructed.	Operations resumed in this year, but production was not steady and there is no information available regarding this.
1933-1943	Aldermac Mines Ltd.	Aldermac mine	Main production period, when the bulk of the ore was treated.	Total ore mined: 2,091,571 tons; produced: 30,845 tons of copper, 10,675 ounces of gold, 389,100 ounces of silver. 557,400 long tons of pyrite were shipped. The average copper content of all ore treated over the life of the mine was 1.65%. Although the content of sphalerite was appreciable, no ZnS concentrates were produced because the smelter at Noranda did not accept

(TABLE 1 CONTINUED)

<u>Years</u>	<u>Company or Individual</u>	<u>Prospect or Mine</u>	<u>Nature of Work</u>	<u>Comments</u>
1937	Aldermac Mines Ltd.	Aldermac mine	Mill was enlarged to 890 tonnes (1,000 tons) per day capacity and steady production began.	ZnS concentrates. Aldermac copper concentrates were heavily penalized due to their zinc content. The mine was closed down when the economic mine reserves were exhausted.
1958-1962	Consolidate Zinc Corp.	The Chance North Contact	Geological mapping, ground magnetic survey, and diamond drilling, 10 holes: 2,650 m (8,321 ft).	The concentrator made two products: a high-grade copper concentrate (20% Cu-90% recovery) and a pyrite concentrate high in sulphur (50% S, 46% Fe).
1966	Teck Corp.	The Chance North Contact Tuff	There is no record of exploration work of any kind for the period 1962-1972.	First geological drilling done in the Aldermac area (holes B-23, B-24; Fig. 3) on a postulated dome-like structure in the rhyolite. Most of the holes tested the main Chance showing.
1972-1973	Cominco Ltd.	Geo. Eng.	Geological mapping, ground geophysics (E.M.), litho-geochemistry, diamond drilling; 5 holes; 1,740 m (5,464 ft).	The Keewill Group (Teck Corporation) acquired the Chance property which then became Geophysical Engineering (Geo. Eng.). For property boundaries see Fig. 14 and Fig. 3.
				Cominco option. Most of these holes tested geological targets, some of which were supported by favourable litho-geochemistry.

(TABLE 1 CONTINUED)

<u>Years</u>	<u>Company or Individual</u>	<u>Prospect or Mine</u>	<u>Nature of Work</u>	<u>Comments</u>
1974-1978	New Inasco Mines Ltd.	West Wasa] * Macanda Geo. Eng. Horne Fault Mines (West Group)	Geological mapping, litho-geochemistry, diamond drilling; 13 holes, for a total of 4,053 m (12,727 ft) to date.	*Options combined and now recognised as West Macanda Resources. Holes drilled shown on Fig. 3 and Fig. 5. The Archibald Prospect (X6) is purely a geological drilling discovery (1975-76). The drilling was testing a thick, pyritiferous tuff thought to overlie chloritized, spotted mafic tuff, tuff breccia, and pillow breccia.

be intimately related to sulphide deposits at Amulet, Aldermac, and near the Vauze mine (Stop 15, Fig. 2), and as a result of his earlier chemical studies, thought that they represented silicified mafic volcanic rocks. Plates 1, 2, and 3 are representative of bimodal breccias from the areas cited above. The identification of this form of alteration at Aldermac has proven very important and may be considered to have upgraded the exploration potential of the area. The problem that remained however, and which was dealt with during the course of this study, was to recognise and map out areas of silicification and then attempt to relate these to sulphide deposition.

The presence of quartz-feldspar porphyritic rhyolite (QFP) and bimodal breccia units similar to those of the Amulet-Millenbach area was deemed encouraging, and revived exploration efforts at Aldermac. Recognition of these rocks coupled with ubiquitous chloritic/sericitic altered volcanics and abundant sulphide showings prompted drilling programmes in the 1970's. The most recent drilling (1975 - 1977) revealed a new sulphide prospect (X₆, Archibald prospect, see Fig. 3).²

The Aldermac deposit has never been considered in a regional, volcanogenic framework. Furthermore, the mine and the other historically significant showings south, south-west, and east of it have never been studied from a structural-

² Prospects and showings discussed in the thesis are numbered 1-6, indicated on Fig. 3 and Fig. 14 by a pick and hammer symbol, and denoted in text as X₁ - X₆.

Plate 1 -- Silicified andesite (bimodal breccia)
near the top of the Amulet Rhyolite
formation at the Amulet "C" deposit
(Stop 19, Fig. 2).

Plate 2 -- Silicified mafic volcanic rock at the
North Chance showing (Fig. 3, X₃).
Note ribbon-like (fracture controlled)
area of alteration near the hammer head.

Plate 3 -- Ribbon breccia member of the Waite Rhyolite formation, 1 km west of the Vauze mine; an example of silicification in andesite pillow breccia and hyaloclastite, which grades upward from a pillowed andesite unit known as the Waite Andesite formation (Stop 15, Fig. 2).

stratigraphic viewpoint. It was felt that there are sufficient outcrop and data from exploratory diamond drilling for such a study to be undertaken.

The objectives of this study of the Aldermac terrain were to:

- a) map and describe the physical nature of the volcanic rocks and intrusions, and to supplement this with chemical analyses and petrographic work;
- b) examine in detail the sulphide showings and attempt to relate these to the volcanic rocks which host them;
- c) examine bimodal breccia and its relationship to sulphide mineralization, which in the Amulet area, 16 km to the north-east, appears to be intimate;
- d) assess the sulphide showings, the recent drilling discoveries, and the old Aldermac deposit within a structural/stratigraphic framework.

The overall intent then is to present a picture of the geology which is compatible with our current understanding of volcanism and ore genesis.

I.3 Methods of Study

From May to November of 1976, I worked in Noranda in the employ of New Inco Mines Limited. My responsibilities were primarily related to the Aldermac area, where the company was engaged in a diamond drilling programme. Concurrent with the exploratory drilling, grids were established, for the purpose

of geological mapping, on the hilly terrain east of the old mine. Due to the complexity of the geology, very detailed mapping (1:600) was required, especially in the area where the drilling was ongoing. In addition, the northeastern portion (north of the MacKay Lake fault) of the map area (Fig. 3) was mapped at a scale of 1:2500 (1" = 200'). Grid mapping was also conducted east and west of the map area within Range VI, Beauchastel township. This was done primarily to meet the assessment requirements of the Ministère des Terres et Forêts du Québec, but also to examine the known sulphide showings and then to study these in terms of the regional geological picture. Most of this work was done by myself, although H.C. Sakrison did some mapping concurrently and also the previous summer.

In August of 1978, with the advantage of having worked at Aldermac and having pondered the geology of the area, I mapped or remapped about half the exposures throughout the map area (Fig. 3). Some of the principal showings and the rocks immediately west and south of the old mine were mapped in detail at a scale of approximately 1:1250, utilizing "flagged-in" grids.

All available diamond drill core was examined and drill core logs were studied with the intention of producing structural cross sections (A-B and C-D, shown on Fig. 3). The only preserved core is that of New Insko Mines Limited, stored north of Noranda at Lake Dufault.

Thin sections, polished thin sections, and polished rock slabs comprising a suite of altered and unaltered volcanics, intrusions, and altered sulphide bearing rocks were studied. The samples examined include material from the drill core of the recently discovered Archibald Prospect (X₆, Fig. 3).

Forty-two whole rock chemical analyses were performed on carefully selected specimens of mafic volcanics, felsic volcanics, gabbro, and "rhyolitic" (silicified) portions of bimodal breccias. These analyses were done on the automated X-ray fluorescence apparatus at the University of Ottawa, (see Appendix).

A very important aspect of this study was to compile all existing surface and mine exploration data, particularly that pertaining to previous mapping and core logging. The structural cross sections presented in this study could not have been attempted without this compilation.

I.4 Exploration History of Aldermac

The first staking at Aldermac is reported to have occurred in 1923. The staker, A.A. MacKay and another prospector by the name of W. Alderson would later have the deposit named after them.

A.V. Corlet, who later became Aldermac mine manager, examined the property in 1924. His interest was immediately focused on a large area of stained rock and gossan on the north side of MacKay Lake. Early exploration on these rusty out-

crops located two small zones of "heavy" to massive sulphides, where chalcopyrite in addition to pyrite is still conspicuous. These are historically known as the Numbers 1 and 2 deposits (shown as X_1 on Fig. 3).

The Aldermac ore body was discovered in the autumn of 1925. A dip needle survey detected some anomalies in low swampy ground 250 m north of the original Number 2 showing. These were subsequently trenched and drilled and the Number 3 deposit (Aldermac Number 3 lens) was found. During the sinking of the shaft, the largest known ore body, the Number 4, was encountered. A vertical projection of the Number 4 ore body is shown on the geological map (Fig. 3, X_4). The Number 3 and Number 4 sulphide masses constituted the bulk of what is known as the Aldermac deposit.

The main production period for the Aldermac mine was from 1933 to 1943. All operations ceased in October of 1943 since the massive sulphides at the deepest levels in the mine were considered uneconomic, and because deep drilling below these levels failed to discover any ore grade material.

Exploratory long-hole drilling was very comprehensive within the mine, and some drilling was done east of the known deposits on the eighth level (see X_4 , Aldermac Mine, in Economic Geology section), but there is no record of surface diamond drilling outside the area of underground exploration.

The first "geological" drilling³ done at Aldermac occurred in the late 1950's and early 1960's (Table 1), and in 1972 stratigraphic targets were drilled in an area about 0.8 km west of the mine. The most recent exploration was done with the concept of "favourable stratigraphy" in mind. New Inasco Mines Limited drilled 13 holes in the period from 1974 to 1977, testing strictly geological targets, intent upon obtaining stratigraphic information. One of these holes intersected previously unknown sulphide mineralization approximately 0.6 km east of the old mine shaft (Fig. 3). This sulphide zone awaits further drill testing (X₆, the Archibald Prospect).

A comprehensive account of exploration and mining activity is presented in Table 1. This is a summary of data from government survey reports, journals, and assessment and mining company files.

1.5 Acknowledgements

I am very grateful to my wife, Celia, who has encouraged me from the beginning, first by urging me to go back to school, and then by actively supporting my efforts while there, including the editing and typing of the thesis.

Dr. J.M. Moore acted as principal supervisor and I thank him sincerely for the opportunity he provided for me to undertake this study. Dr. J.M. Franklin (G.S.C.) visited the thesis

³ Drilling designed to test certain lithologic contacts, such as "cherty" tuff (exhalite) at the interface of a rhyolite dome and a mafic flow.

area, made himself available for discussion, and read and improved the initial and final manuscripts. His show of interest and help is greatly appreciated. Dr. D.H. Watkinson contributed valuable criticism and provided funds for chemical analyses.

Both H.L. Gibson and J.A. Ayer, fellow students and friends, have provided valuable discussion on many occasions. They, with the author, studied petrological, chemical, and economic aspects of the Aldermac rocks as a class project for Geology 520, a graduate course at Carleton University, supervised by D.H. Watkinson. Harold Gibson's own thesis study in Noranda is closely related to certain aspects of the Aldermac project, and his observations were of great benefit to myself.

The efforts of New Inasco Mines Limited initiated the study, and I wish to thank D. Hume, and especially G. Archibald, H.C. Sakrison and C. Authier for sharing their many years of combined work experience in Noranda, and for allowing me considerable freedom in my work. It was a pleasure to work and to discuss historical aspects of the Noranda area with C. England and C. Authier.

St. Joseph Explorations Limited provided some financial assistance and allowed me one month in 1978 in which to do field work at Aldermac. Chemical analyses were performed by R. Hartrey at the University of Ottawa and by X-Ray Lab-

oratories of Toronto. R. Taylor at Carleton University made very good thin sections, and J. Baker performed X-ray diffraction analyses on a number of samples. The final geological map was drafted by Franco Costello, and the final copy of the thesis was typed by S. Pelletier.

CHAPTER II

Geology of the Aldermac Area

II.1 General Geology

The Abitibi Orogenic Belt of Archean age is the largest single continuous tectonic unit of its type in the Canadian Shield, and contains eleven volcanic complexes (Fig. 1).

The Noranda-Benoit volcanic complex, the best understood volcanic domain, straddles the Ontario-Québec border and occupies a southerly position within the Abitibi belt. The rocks constituting the complex are known as the Blake River Group (Fig. 1). Variolitic mafic volcanics form a characteristic marker horizon at the base of the Group, which outlines the complex as shown in Fig. 1 (Dimroth et al., 1975). The only felsic volcanic centre known in the complex lies at Rouyn-Noranda in the eastern part.

The Blake River Group is believed to interfinger with the Pontiac Group of flyschoid sediments (Gunning and Ambrose, 1939) which is described by Dimroth et al., (1975) as part of a large turbidite fan and basin fill, which underlies a vast area south of the Noranda volcanic complex.

The deposition of sediments of the Temiskaming Group, characterized by volcanogenic turbidites and conglomerate with minor volcanics, may in part correlate with the last stage of Pontiac deposition (Dimroth et al., 1975). Al-

though local unconformities have been established (Goodwin and Ridler, 1970), the Temiskaming Group is believed to interdigitate with the Blake River Group. South of Noranda, these sediments form an east-trending, faulted, asymmetrical synclinorium which is located between the Pontiac and Blake River assemblages (Fig. 2).

Sedimentary rocks of the Archean Cobalt Group unconformably overlie all Archean rocks and form the very prominent Kekeko Hills south of the Aldermac area.

Late Precambrian quartz and olivine-bearing diabase dikes cut all aforementioned rocks and trend north, northwest and northeast. One dike, 0.5 km east of the Aldermac shaft is traceable for tens of kilometres.

The regional grade of metamorphism in the Abitibi belt has attained the greenschist facies and the volcanics have been deformed into a series of tight isoclinal folds (Goodwin and Ridler, 1970). However, in the Noranda area a large elliptical-shaped region may be outlined (Fig. 1) within which there has been little deformation, and the rocks locally exhibit subgreenschist mineral assemblages (Jolly, 1978). Within this area faults and intrusions are the most prominent features; in addition, a variety of intrusive rocks bears a close spatial relationship to the faults. The structural setting of the Noranda area has been likened to that of a caldera (de Rosen Spence, 1976).

A variety of mafic and felsic volcanic rocks are well represented at Aldermac. However, the dominant features of the geology are the mafic intrusions and a centrally located syenite mass. Also, faults and lineaments are prominent; the MacKay Lake Fault is part of a regional fracture system which extends eastward to Lake Osisko and Lake Dufault at Noranda (Fig. 2). The Cadillac-Larder Lake Break occurs approximately 3 km south of Aldermac where it is concealed beneath the Kekeko Hills (Ambrose and Ferguson, 1945). The intensely sheared and carbonatized greenstones underlying the low flat area between these hills and Aldermac harboured past-producing gold deposits, including the Francoeur, Arntfield, and Wasa Lake mines.

II.2 Detailed Geology of the Aldermac Area

G.S.C. Map 45-17B, produced by Ambrose and Ferguson, was the best available for the Aldermac area until the present study (see Fig. 4). Several features of this map are:

- a) the area is shown as underlain predominantly by "acid" volcanic rocks, mafic volcanics being subordinate;
- b) the southern contact of a large syenite intrusion lies near the Aldermac deposit;
- c) an elongate, trough-shaped area of mafic volcanics west of the mine is coincident with the axis of an inferred syncline, which trends approximately east-west. The author's mapping shows that if this structure existed it would have to have a variable plunge along its length, since its east-

Figure 4: Map Legend

Figure 4 -- Geological map of the Aldermac area (part of GSC Map 45-107B, Ambrose and Ferguson, 1945).

ern closure plunges steeply west, yet west of the mine the fold axis may be inferred to be almost horizontal.

The present study reveals the geology to be much more complex than that previously presented. On the basis of detailed mapping the volcanic rocks have been divided into two major groups, mafic and felsic. In addition to these a third category has been distinguished as "altered volcanics". These latter rocks have been found to be the silicified equivalents of the mafic volcanics and have in the past been mapped as rhyolite. The silicified rocks are recognised on the basis of textural/structural features and on chemical grounds. The map legend (Fig. 3) begins with the number 3 in order to conform with the previous mapping and diamond drill logs of New Insko Mines Ltd. The numbers 1 and 2 refer to volcanic stratigraphy occurring outside the map area.

II.2.1 Mafic Volcanic Rocks

Mafic volcanic rocks are distributed throughout the map area. They, and their altered equivalents, are more abundant than the felsic volcanics. However, because of the alteration, primarily silicification, of large areas of andesite, much of the terrain has in the past been interpreted to be underlain by rhyolite (see Fig. 4).

These rocks are variable in colour on weathered surfaces, ranging from dun-greenish brown to pale-to-very-dark green.

The "unaltered" mafic volcanics exhibit the mineral assemblage albite + actinolite + epidote + chlorite + titanite + quartz + white mica, and their variation in colour appears to be a function of that amphibole, and the chlorite and oxide content of individual specimens. Fresh surfaces are dark green to black.

For the purpose of mapping, units were subdivided into flows, pillowed or massive; pillow breccias; and tuff and tuff breccia. The degree of vesicularity and the size and relative abundance of any phenocrysts were carefully noted. In a general way, these distinctions were valid in very detailed mapping (1:600 or 1:2500) but were useful only in an area of continuous outcrop, such as on Macanda Hill (Fig. 5), where map units are traceable.

At Aldermac, individual flows or tuff-breccia horizons cannot be traced more than 150 m. No significant marker horizons were detected on surface, but there may be an analog to the "C contact" and "main contact" tuffs of the central Noranda mining camp (Simmons et al., 1973). This is the North Contact tuff (X₅, Fig. 3) which crops out about 1 km west of the Aldermac shaft. This tuff, which marks the base of the unaltered andesite, was intersected in Zinc Corporation and Cominco drill holes, and may have a strike length of over 1 km.

Pillow structures are well developed immediately south of the North Contact tuff. To the west, within the same andesite unit, there are good pillowed exposures.

Figure 5 -- Geology of Macanda Hill. This map area is shown on Fig. 3. The legend of Fig. 3 applies to this figure. H.C.S. is H.C. Sakrison.

The only other area where these flow structures are well displayed is east of the old mine on Macanda Hill and the area north of this hill.

Rocks mapped during the course of this study as isolated pillow breccias are considered to be very similar to those described by Carlisle (1963) on Quadra Island, British Columbia. Plate 4 shows a typical exposure of pillow breccia. There is a large proportion of very fine material, interpreted to be hyaloclastite, supporting diversely shaped, both angular and amoebiform, lava fragments. Intercalated with these rocks are mafic tuff and tuff breccia. Both bedding and fragments are indistinct, being conspicuous only locally on weathered surfaces without lichen, and are virtually unrecognizable on fresh surfaces.

The mafic fragmentals are very poorly sorted, consisting of angular blocks up to 0.5 m across set in fine - to coarse-grained tuff. Within some beds, the framework is intact, but within others matrix far outweighs lapilli and block-size material. They have been designated as tuff breccia on the geologic map.

Many of the blocks are markedly porphyritic and/or amygdaloidal; others are highly epidotized; still others

Plate 4 -- Pillow breccia, approximately 1 km
east-northeast of the Aldermac shaft.
This lithology is best developed in
the northeast portion of the map area.
Lens cap is 5 cm across.

are of low vesicularity similar to pillow breccia fragments. Some silicified mafic volcanic blocks have also been observed. The tuffaceous matrix to the blocks is characterized by chlorite (at least two varieties) + actinolite + plagioclase + quartz + opaques $\pm$ titanite. Little or no epidote is present. There are however highly epidotized tuff and tuff-breccia occurrences, which are spatially associated with areas of intense hydrothermal alteration marked by silicification and sulphide mineralization. These will be discussed below in detail, in the section entitled "Altered Volcanic Rocks" Chapter II.2.3).

The mafic flow rocks are commonly amygdaloidal and porphyritic. Amygdules comprise quartz, epidote, albite $\pm$ chlorite $\pm$ actinolite in highly variable amounts and proportions. Their size and shape is equally variable, ranging from 4 cm (egg size) to less than 1 mm, and although commonly round, they are also elongate and in places flattened. The most flattened ones have been seen to lie parallel to cooling cracks in some instances. Quartz is by far the most common vesicle-filling mineral, but epidote, amphibole and chlorite are also conspicuous. The percentage of amygdules ranges from five to thirty. Some scoriaceous blocks in tuff-breccia units are representative of the most vesicular material.

In a typical mafic flow rock phenocrysts of feldspar range considerably in size with a maximum dimension of from 3 to 4 mm. They exhibit seriate and micro-glomeroporphyratic textures. The feldspar is invariably altered or saussuritized, albite prevailing, but one determination of approximately An_{35} (andesine) was made on very fresh looking material occurring about 1 km east-north-east of the mine shaft. The feldspar phenocrysts are set in an extremely fine-grained matrix of acicular amphibole and albite microlites with minor epidote, titanite and opaques.

Several occurrences of mafic phenocrysts were noted; these accompany feldspar phenocrysts set in a microlitic-textured groundmass (Plate 5). They are pyroxene pseudomorphs, composed of light green pleochroic amphibole. One such grain was noted to have a relict colourless pyroxene core. Optically, this core is positive with an intermediate 2V, indicating it to be a clinopyroxene.

Feldspar in the groundmass defines very well developed microlitic textures, with length to width ratios of microlites commonly greater than or equal to 10:1. This texture is shown in Plate 6, and attests to the remarkable preservation of primary features despite metamorphism. In relatively coarse-grained aphyric

Plate 5 -- Partial pseudomorph of pyroxene set in microlitic groundmass in porphyritic andesite (sample A-35, see Table 2). The light coloured areas of the phenocryst were determined to be relict clinopyroxene which has been partly altered to pale green amphibole. The pyroxene is 0.4 mm in maximum dimension and is set in a matrix of albite, actinolite and opaques.

Plate 6 -- Andesine phenocryst 0.5 mm long set in a matrix of crudely aligned albite microlites, actinolite, and opaques. Sample locality near that of Plate 5, in the east-central portion of the map area (Fig. 3).

flows, intergranular texture, characteristic of the mafic intrusions, is well developed.

II.2. Felsic Volcanic Rocks

Rhyolite exposures characteristically weather light grey, light yellow-brown and light brown (see Plate 7). Fresh surfaces are commonly very dark green and brown and in some cases black.

Texturally, rhyolite is commonly porphyritic, the groundmass being aphanitic in most instances. Feldspar is an ubiquitous phenocryst accompanied by highly variable amounts of quartz. In many cases, quartz eyes or phenocrysts are observed only in thin section, but a striking exception are those rocks termed quartz feldspar porphyry (QFP). This is a rock type identical to that described by B.D. Simmons et al., (1973) occurring in the Millenbach mine.

In the Aldermac area, QFP usually forms sill-like bodies. One such body, having a strike length of over 0.5 km and an average width of 30 m occurs just 200 m south of the shaft. Another concordant unit with an associated tuff-breccia crops out in the northwestern part of the map area (see Plate 8). It has a strike length of approximately 1 km and an apparent thickness

Plate 7 -- Altered and brecciated material within the rhyolite dome at Macanda Hill. This is an internal facies of the dome, partly surrounded by a zone of crumble breccia and tephra.

Plate 8 -- Quartz-feldspar porphyritic (QFP) tuff breccia in the northwest corner of the map area (Fig. 3). This forms a mappable unit which overlies a massive homogeneous QFP. Note the bleached (silicified) appearance of many fragments. Lens cap at upper left is 5 cm across.

of from 100 to 125 m.

Small, dome-like fragmental bodies of QFt have been mapped, for example immediately northwest of the old mine shaft. Rhyolite exposed on Macanda Hill (Fig. 5) is also interpreted to be an example of a dome. This is a very complex rhyolite mass, composed largely of flow-laminated and auto-brecciated material and very large, extremely siliceous blocks, up to 3 m long (Plates 7, 9, 10, and 11). Quartz and feldspar phenocrysts are only locally conspicuous, for example in mixed crumble breccia⁴ and pyroclastics on the east and south margin of the dome.

About 100 m east of the dome is an elongate exposure of quartz crystal-rich, pumiceous tuff. This tuff is very subtly foliated and lies along an interpreted syn-volcanic fault, the same structure that defines the north contact of the rhyolite dome. It is locally discordant to bedded mafic fragmental rocks. The pumice fragments peculiar to this felsic body commonly exhibit very intricate and delicate-looking forms including hair-like projections (see Plates 12 and 13). Combined field and petrographic evidence then, indicate this particular rock to be a pyroclastic intrusion or a tuff

⁴ Material sloughed off the outer, rapidly cooling "skin" of an expanding lava dome.

Plate 9 -- Flow banded, locally amygdaloidal rhyolite on the southeast margin of the rhyolite dome on Macanda Hill. This is intercalated with blocky crumble breccia and quartz crystal-rich pyroclastics.

Plate 10 -- Flow banded rhyolite like that of Plate 9. The banding is defined by the relative proportion of chlorite and the degree of vesicularity. Perlitic texture like that shown in Plate 14 is observed in some bands. This example comes from the extreme west-central part of the map area.

Plate 11 -- A large, silicified block of rhyolite, 3 m across (sample A-11, Table 3) in the rhyolite dome at Macanda Hill (note also Plates 7, 9, and 10). Lens cap is 5 cm across.

Plate 12 -- Pumiceous tuff from a dike at Macanda Hill. There are fragments of pumice at the centre of this photomicrograph. Quartz eyes and siliceous rock fragments are conspicuous features. Maximum dimension of field is 2 cm. Plane - polarized light.

Plate 13 -- Closeup of pumice from same specimen shown in Plate 12. The pumice particle is defined by chlorite and opaque(s). Note the elongate-tubular vesicles and the delicate (locally cuspidate) outline of the pumice. Maximum dimension of field is 5.5 mm. Plane-polarized light.

dike (personal commun., M.B. Lambert, 1979). The orientation of the dike is subparallel that of the Mackay Lake Fault and a rhyolite unit within and immediately south of this fracture system.

Other well exposed rhyolite domes and/or flows have been mapped. These occur on the Guertin et Fils gravel pit road about 60 m north of the main gate and within the west-central portion of the map area (see Fig. 3). Here the felsic volcanics have, in addition to some of the features described above, well developed flow banded amygdaloidal zones (Plates 9 and 14) and primary cooling joints.

The QFP carries up to 15% by volume combined quartz and albite phenocrysts. The quartz is equant, subhedral and ranges from 0.2 to 2.5 mm across. Plagioclase feldspar commonly occurs in clusters of several subhedral grains up to 4.0 mm across. It is epidotized and easily discernible on fresh or cut surfaces. The groundmass is like that of most rhyolite samples studied, a microscopic intergrowth or matte of quartz and albite, with larger domains composed predominantly of sutured and polygonized quartz (Plate 15). Minor constituents include sericite, chlorite, epidote, titanite, carbonate and

Plate 14 -- Flow banded rhyolite. Note lower amygdaloidal layer and upper perlitic textured layer. Field of view is 2 cm in maximum dimension. Same locality as that of Plate 10. Plane - polarized light.

Plate 15 -- An example of intrusive QFP (sample A-45, Table 3) in thin section. Note the large partially resorbed quartz phenocryst. The groundmass is largely quartz and albite. Field of view is 5.5 mm. This example occurs 0.3 km southwest of the Aldermac mine shaft (shown in Fig. 6). Cross-polarized light.

and opaques.

The typical rhyolite samples that were examined are texturally monotonous, the main variable being the amount, proportion, and size of albite and quartz phenocrysts. However, in some very siliceous specimens, the quartz occurs as round or ovoid "eyes" rather than subhedral grains. In addition, some specimens show well developed microspherulitic and perlitic textures. Plates 12 to 19 inclusive show the variety of textures observed.

The amount of sericite and epidote varies considerably from specimen to specimen, and acicular actinolite is conspicuous in only a few thin sections. Flow banding is defined predominantly by the relative proportion of chlorite, epidote and sericite. However, in some cases, extremely fine, elongate, quartz-rich lenticles define a subtle foliation. The quartz of these is coarser grained than that of the ground-mass, and chlorite in places occurs in the central portion of the lenticle (Plate 19).

II.2.3 Altered Volcanic Rocks

i) Silicification

Silicified mafic volcanic rocks are denoted as 4a, or

Plate 16 -- Extremely siliceous (sample A-81, Table 3) spherulitic rhyolite (note upper left). This example is a block in a rhyolite flow, 0.8 km south-southwest of the Aldermac mine shaft. Field of view is 5.5 mm in the maximum dimension. Cross-polarized light.

Plate 17 -- A block (Plate 11) of rhyolite from the rhyolite dome at Macanda Hill in thin section. The albite crystal in the centre is 0.6 mm long. Note the groundmass texture and compare it to Plates 20 and 22. Cross-polarized light.

Plate 18 -- Porphyritic rhyolite. Many of the quartz eyes are only 0.3 mm across and thus the rock is not conspicuously porphyritic in outcrop. Compare to Plate 15 and refer to chemical analysis A-70 (Table 3). Field of view 5.5 mm. Cross polarized light,

Plate 19 -- Sericitized plagioclase and round quartz phenocrysts in flow laminated tuffaceous rhyolite. Note the quartz lenticles and threads, accentuated by chlorite, which defines the primary structure. This rock contains large blocks including the one shown in Plate 16. Field of view 2 cm. Plane-polarized light.

4aa on Fig. 3. Unit 4a denotes weak or incipient alteration where there are bleach-haloes around amygdules and/or the groundmass is mottled. The mottling may be a very subtle feature (Plate 20), or it may be quite conspicuous where a network of tiny silica-rich veinlets is developed. In such cases the texture is still well preserved, and the colour index is indicative of mafic volcanics.

The more extreme example of silicification is denoted by 4aa (Plates 21 and 22). Mafic volcanic rocks have been intensely silicified within a triangular area whose apices are broadly defined as Macanda Hill, the North Chance showing, and the large exposures south of the Chance prospect (X_2 , X_3 , and X_6 , Fig. 3). The most outstanding feature of the alteration is its close relationship to structural elements of the area. The MacKay Lake Fault and less persistent parallel faults have an intimate relationship to areas of intense silicification, as they do to diorite intrusions and feeders to felsic intrusions (e.g., the Macanda Hill tuff dike). The Aldermac terrain is a complexly faulted one and it is noteworthy that areas of intensely altered rock are characterized by faults of several orientations. The settings of the Chance and Archibald Prospects exemplify this relation.

Plate 20 -- Incipient "mottle" silicification in andesite (sample A-60, Table 2). Note the well defined albite microclites and the silica rich patches throughout. Before this sample was examined in thin section, it was judged to be representative of an unaltered mafic flow rock. Field of view 5.5 mm. Plane-polarized light.

Plate 21 -- Intensely silicified area (sample A-44, Table 4) within a mafic flow at the Sakrison Vent (occurs 0.3 km south-west of the Aldermac shaft, see Fig. 6). Ten-cent piece included for scale is 1.7 cm in diameter.

Plate 22 -- Photomicrograph of intensely silicified amygdoloidal andesite at the top of the Sakrison Vent (sample A-65, Table 4). Note the well preserved micro-litic texture despite the destruction of the original mafic minerals. Field of view 5.5 mm. Cross-polarized light.

One very good megascopic example of the discordant nature of silicified zones will be discussed in detail in the economic geology section below. This, the Sak-rison Vent (see Fig. 6) occurs immediately west of the Mackay Lake sulphide zone (X₁, Fig. 3). Here, an area of silicification crosscuts mafic flow and fragmental units. To either side of this altered area the volcanics exhibit local patchy silicification, which upon close inspection is seen to develop commonly in the more vesicular or fractured areas of the flows or flow units. In some instances (Plate 23) silicification proceeded along what have been interpreted in the field to be flow or flow unit contacts. Clearly the most important factor here is the primary permeability of the rocks. These field relations indicate this discordant zone of alteration to represent a hydrothermal vent which intermittently was the locus of magmatic activity.

At Aldermac, some intensely silicified fragments, patches and ribbons (fracture controlled silicification) record their original cooling and crystallization features. In these, amygdaloidal structure and microlitic groundmass textures are well preserved. The texture of silicified mafic volcanic rocks can be used

Figure 6 -- Geology of the Sakrison Vent. This map area is outlined on Fig. 3. The legend of Fig. 3 applies also to this map. Outcrops here are shown in solid outline. Cross-hatching marks an area of disseminated and fracture controlled sulphides (a stain zone). Hachured lines represent cliff faces.

Plate 23 -- Ribbon-like zone of silicification in andesite. This developed along an originally permeable feature such as a flow or flow-unit contact. From the east-central portion of the map area near the locale of sample A-37 (shown on Fig. 3).

as a criterion for distinguishing these from rhyolite (compare Plates 12-19 to Plates 20-22). For example, one exposure was mapped as rhyolite until a thin section revealed a high proportion of well developed microlites (Plates 20 and 22). The chemistry of the specimen was subsequently found to support the petrographic evidence that the sample was originally mafic in composition (sample A-83, Table 4).

In thin section, these rocks are distinguished by their microlitic texture characteristic of basalts and andesites, and by the sparsity of mafic minerals. The minerals quartz and albite predominate; the former encloses albite phenocrysts and microlites and in some instances is seen in a polygonal, sutured form, pseudomorphing plagioclase. In addition, epidote, titanite, $\pm$ carbonate, amphibole and opaques occur in the groundmass. In some specimens, there appears to be no amphibole, and chlorite was rarely observed. The mineral titanite is noticeably abundant in one analysed specimen (see A-12, Table 4).

Amygdules in silicified mafic volcanic rocks are typically and conspicuously filled with quartz and epidote. However, unlike their unaltered equivalents, amygdules also commonly contain calcite and garnet.

The garnet is usually pale orange or yellow-brown to honey-coloured, and has the optical characteristics of a grossular-andradite species. This has been verified by X-ray diffraction analysis.

At Aldermac, silicification is the most extensive and best developed form of metasomatism. It is also an important aspect of the geology of some deposits near Noranda. The Amulet Rhyolite formation (de Kosen Spence, 1976), the footwall to most of the Amulet deposits, is intensely silicified in its upper portion, from the Amulet "C" (Fig. 2) to the Millenbach deposit (personal commun., C.D.A. Comba, Falconbridge Copper Limited, 1978). The latter is over 2 km down dip from the near-surface Amulet "C" deposit, attesting to the regional significance of silicification. E.L. Gibson (1979) recently mapped a section through the Amulet Rhyolite very near the new Corbet shaft (see Fig. 2, Stop 18, near Amulet). He finds that as much as 80% of this "rhyolite" formation is actually silicified mafic volcanics. He has studied this form of metasomatism and tried to quantitatively assess chemical transfer. According to his work, silica is definitely added to silicified rocks (Gibson, 1979).

At Aldermac, rocks originally referred to as "bimodal breccias" were suspected by H.C. Sakrison of being silicified mafic volcanic rocks. This identification has been confirmed; bimodal breccias are metasomatized basalts and andesites. The white siliceous "blocks" or ribbons in many cases are patches or fracture-controlled

areas of silicification, not discrete fragments. There are however examples both at Aldermac (see Plates 24, 25 and 26) and in H.L. Gibson's Amulet Rhyolite section where true silicified fragments occur in tuff or andesite flows. This relation indicates that silicified zones or vents contributed material to fragmental units. Altered material was also incorporated in later lava flows.

ii) Epidote Alteration

Another signature of hydrothermal alteration in the Aldermac terrain is epidote and the closely associated minerals calcium-rich garnet and calcite.

These minerals are well represented at most of the sulphide showings described below, but epidote is by far the most conspicuous. Once garnet was first recognized, it became possible to find it wherever one looked for it, in areas of altered volcanics. It is not common in the extremely silicified mafic volcanics, but is conspicuous in epidote-rich "patches" within much larger areas characterized by silicification.

The best example of the occurrence of the alteration-trio epidote + garnet + calcite is found in drill core of the Archibald Prospect; however the garnet was not recognized during drilling. The garnet is commonly a pale orange-brown colour. All three minerals occur in amygdules and fractures. Hydrothermal alteration proceeded outwardly from these origin-

Plate 24 -- Intensely silicified amygdaloidal mafic volcanic fragment (sample a-12, Table 4) from a mafic tuff breccia unit 450 m east of the Chance showing (X₂, Fig. 3). The fragment shown has dimensions of 7 cm by 4.5 cm.

Plate 25 -- Silicified mafic hyaloclastite from the Waite Rhyolite formation-ribbon breccia member. This sample was collected from the same exposure shown in Plate 3. The polished slab is 19 cm long and the fragment in the upper left is 4.5 cm across.

Plate 26 -- This specimen from 0.5 km east of the Chance showing is analogous to that of Plate 25. Silicified mafic volcanic fragments occur in a mafic tuff breccia matrix. Length of the polished slab is 17 cm.

ally permeable features in the volcanics. Incipient alteration manifests itself as sub-millimetre epidote-rich bleaching haloes around amygdules which are filled with epidote, garnet, calcite, and quartz. Primary fractures are defined by concentrations of these same minerals, in places connecting amygdules and accounting for larger patches of progressively altered rock. In extremely altered examples where the original mafic volcanic rock is intensely fractured, remnants of less altered rock have highly epidotized margins (Plates 27 and 28) and the fractures themselves are filled predominantly with garnet.

Epidote and garnet are especially conspicuous in altered rock examined on the Aldermac waste dumps. They, along with calcite, have been observed at the Chance, North Chance, MacKay Lake and Archibald sulphide showings and prospects. These minerals are an indicator of hydrothermally altered zones in the volcanics just as are the other types of alteration. Their close spatial association with mineralization could be an important indicator, particularly where geological drilling for "blind" sulphide deposits is concerned.

Field work at Aldermac has proven that there is a close spatial relationship between silicification and epidote alteration. Where both types of alteration are well developed and where there are associated sulphide occurrences (e.g., The Chance, Sakrisson Vent) epidote alteration is prominent immediately outside the mineralized zone. The intensely silici-

Plate 27 -- Drill core from 995 ft, hole M76-1 (Archibald Prospect, Fig. 5). This rock is pseudobreccia produced by intense hydrothermal alteration of mafic volcanic rock. The darker areas are occupied predominantly by calcic garnet; the light areas are composed primarily of epidote. The intermediate grey "fragments" are remnants of bleached grey mafic volcanic rock.

Plate 28 -- Calcic garnet, quartz and pyrite filling a vesicle in mafic volcanic rock, from drill core of hole M76-1 (946 ft). The amygdule is 4.5 mm across. Cross-polarized light.

fied rocks are more intimately related to the sulphide mineralization, and at the Sakrison Vent (Fig. 6) are seen to have a cross-cutting relationship with an epidotized mafic flow. Recent mapping by H.L. Gibson (personal commun., 1979) at the Millenbach deposit and on surface in the Amulet area has shown alteration characterized by epidote + quartz to be slightly earlier than well developed zones of silicification.

iii) Chlorite-Sericite Alteration

The well documented (Riverin, 1977) typical alteration minerals associated with Noranda-type proximal volcanogenic sulphide deposits, chlorite and sericite, are found in close association with most of the sulphide showings and the Aldermac sulphide lenses discussed in the economic geology section of this study. In fact, a significant observation made by Bruce (1931) was that chlorite was intimately related to the Aldermac sulphide deposits. Hawley (1948) observed that the No. 4 orebody passed into disseminated sulphides in a chloritic alteration zone of tuffs and agglomerates below the 1,400 foot (445 m) elevation, again suggesting the coeval development of chlorite and sericite with the sulphides. At the Millenbach mine, these minerals predominate in "pipes" immediately beneath the orebodies. No such "pipe geometry" has ever been documented for the Aldermac mine or any of the other sulphide showings.

Hydrothermally produced areas of chlorite-sericite alter-

ation in the volcanics are typically marked by a spotted texture which, where it is defined by phyllosilicate-rich porphyroblasts, has long been known in Noranda and termed "dalmatianite". This texture at Noranda has developed in the thermal aureole of the Lake Dufault Granodiorite and was therefore overprinted on the altered volcanics by contact metamorphism (de Rosen-Spence, 1969; Kelly, 1975).

Throughout the Aldermac area, the "spots" are commonly defined by aggregates of chlorite, but in sericitized rocks spots consist of concentrations of biotite with minor quantities of quartz, sericite, and opaques.

Where chlorite spots are well developed, they range in size from 1.0 to 10.0 mm. The spots are seen in thin section to be concentrations of subhedral shreds and plates of chlorite. Accompanying this chlorite are minor amounts of quartz, $\pm$ biotite, $\pm$ sericite and opaques. Chlorite in the groundmass commonly is optically distinct, by its birefringence, from the coarser grained chlorite species defining the spotted texture. The spots have overgrown primary volcanic features, such as cooling cracks in lava and pyrite and chalcopyrite mineralization filling these (Plate 29) and thus clearly postdate them. They are thus metamorphic in origin and probably grew during the thermal events associated with the emplacement of the syenite intrusive complex and (?) the gabbro-diorite intrusions.

Chlorite and sericite alteration, where severe, results

Plate 29 -- Silicified and spotted mafic volcanic rock of the Mackay Lake showing. The spotted texture is analogous to "dalmatianite" at the Amulet "A" and "C" deposits. The spots are superimposed on stringer-type, pyrite + chalcopyrite mineralization indicating their origin to be metamorphic. The largest "spots" are about 1 cm in diameter.

in complete destruction of the original igneous texture of the volcanics. Where outlines of feldspar are noted, they are seen to be replaced by sericite. In contrast, the original texture of silicified volcanics is often preserved.

Both types of alteration discussed previously may be closely related to the deposition of volcanogenic sulphides, but alteration marked by chlorite and sericite appear to be the most intimately related. At Aldermac, chloritic alteration has been observed to postdate intense silicification, as may be demonstrated at the Sakrisen Vent where the main silicified zone is cut by a mafic feeder dike which itself is chloritized and exhibits dalmatianite texture. The alteration pipes beneath the massive sulphide bodies of the Millenbach mine are superimposed on intensely silicified volcanic rocks, demonstrating the chlorite and sericite to represent a later type of alteration which was coeval with the deposition of the sulphide deposits.

II.2.4 Chemistry of the Volcanic Rocks

Whole rock chemical analyses were performed on a representative suite of mafic and felsic volcanic rocks (see Tables 2 and 3). In addition, a number of examples of intensely silicified, mafic volcanic rock and a few samples of siliceous rock of dubious origin were analysed (Table 4). This was done to see if the known silicified mafic rocks are chemically distinct and to assess their chemistry along with the "unaltered"

Sample No.	A-5e	A-19	A-35	A-37	A-40	A-46*	A-47	A-48	A-48A	A-60	A-76	A-87
SiO ₂	61.52	55.03	53.14	53.07	57.36	49.76	60.73	61.50	50.35	62.23	48.89	59.20
Al ₂ O ₃	12.44	17.00	18.13	15.58	15.59	15.05	15.30	15.13	17.14	14.95	16.97	18.81
Fe ₂ O ₃ T	10.15	8.68	9.69	12.16	10.73	11.89	8.85	8.79	10.54	7.38	11.77	7.98
MgO	3.50	4.44	4.68	4.94	3.47	7.08	2.91	2.27	7.46	2.66	6.67	3.01
CaO	5.59	9.18	7.47	8.04	6.53	11.93	5.76	4.25	8.45	5.45	10.86	1.86
Na ₂ O	2.15	3.31	3.13	3.05	3.51	1.54	4.58	6.02	1.85	6.08	2.95	5.19
K ₂ O	1.15	0.86	1.53	0.31	0.19	0.45	0.52	0.13	0.52	0.29	0.49	1.19
TiO ₂	1.20	0.96	0.99	1.54	1.66	1.04	1.04	1.28	1.15	1.50	1.07	0.62
P ₂ O ₅	0.15	0.10	0.09	0.17	0.22	0.06	0.18	0.27	0.12	0.25	0.12	0.08
MnO	0.18	0.16	0.20	0.25	0.20	0.19	0.15	0.20	0.12	0.18	0.17	0.13
S	N.D.	0.03	0.04	0.02	0.01	0.05	0.01	0.04	0.00	0.09	0.01	0.00
L.O.I.	0.83	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total	98.87	99.75	99.09	99.13	99.47	99.04	100.03	99.84	97.70	101.06	99.97	98.07

Table 2: Chemical analyses of mafic volcanic rocks and gabbro (A-46*). All sample locations are shown on Fig. 3. Fe₂O₃T = Total Fe calculated as Fe₂O₃; this applies also to Table 3 and Table 4.
 All analyses were done on the XRF apparatus of the University of Ottawa by R. Hartrey, with the exception of A-5e done at X-Ray Laboratories, Toronto.
 N.D. - Not determined. L.O.I. - Loss on ignition.

Sample No.	<u>AM-1</u>	<u>A-1</u>	<u>A-2</u>	<u>A-4</u>	<u>A-5</u>	<u>A-11</u>	<u>A-14C</u>	<u>A-45</u>	<u>A-70</u>	<u>A-71</u>
SiO ₂	71.73	71.20	72.43	70.09	81.83	77.02	81.02	77.20	74.10	76.00
Al ₂ O ₃	10.84	12.33	13.08	13.16	9.00	11.41	8.63	11.18	12.57	11.22
Fe ₂ O ₃ T	5.32	2.78	3.49	4.59	1.68	1.49	1.48	2.44	4.90	2.96
MgO	1.04	0.29	0.44	0.50	0.20	0.01	0.05	0.01	0.75	0.37
CaO	6.27	1.80	1.98	3.28	2.16	0.65	1.03	0.51	1.02	1.06
Na ₂ O	2.83	1.21	3.97	3.44	3.68	4.02	4.49	4.77	6.09	6.13
K ₂ O	1.15	8.12	3.06	3.81	0.23	3.33	0.24	2.38	0.26	0.23
TiO ₂	0.32	0.40	0.44	0.46	0.16	0.22	0.27	0.16	0.39	0.23
P ₂ O ₅	0.05	0.09	0.09	0.09	0.01	0.02	0.04	0.00	0.06	0.01
MnO	0.16	0.08	0.09	0.13	0.04	0.03	0.07	0.03	0.09	0.06
S	0.11	0.03	0.02	0.05	0.03	0.01	0.00	0.00	0.01	0.00
Total	99.82	98.33	99.09	99.60	99.02	98.21	97.32	98.68	100.24	98.27

Table 3: Chemical analyses of felsic volcanic rocks. All samples are located on Fig. 3 except AM-1 a representative sample of massive rhyolite from the Aldermac waste dump and 0-1 and 0-11, collected immediately west of the map area approximately 100 m north of the motor access road (within Horne Fault Mines Ltd., West Group)

Sample No.	<u>A-74</u>	<u>A-80</u>	<u>A-80A</u>	<u>A-81</u>	<u>A-84</u>	<u>A-112A</u>	<u>A-118</u>	<u>0-1</u>	<u>0-11</u>
SiO ₂	73.63	83.34	76.95	85.47	74.48	80.44	73.81	79.37	80.05
Al ₂ O ₃	12.62	9.49	11.88	8.35	11.88	10.65	12.31	9.30	8.52
Fe ₂ O ₃ T	4.50	0.90	3.57	0.73	3.98	1.92	2.94	2.18	2.43
MgO	0.56	0.00	0.63	0.00	0.52	0.26	0.22	0.36	0.80
CaO	2.98	0.56	1.45	0.61	4.15	1.48	2.22	1.58	1.91
Na ₂ O	3.52	4.77	1.06	4.28	1.48	4.48	1.69	2.84	3.21
K ₂ O	1.20	0.50	2.89	0.44	2.05	0.50	5.39	1.34	0.92
TiO ₂	0.38	0.21	0.27	0.19	0.28	0.39	0.23	0.25	0.22
P ₂ O ₅	0.05	0.00	0.03	0.02	0.02	0.07	0.02	0.03	0.03
MnO	0.06	0.03	0.06	0.03	0.13	0.06	0.08	0.05	0.03
S	0.00	0.00	0.00	0.00	0.14	0.02	0.02	N.D.	N.D.
L.O.I.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3.42	0.82
Total	99.50	99.80	98.79	100.12	99.11	100.27	98.93	100.75	98.94

Table 3: (continued)
Analyses of samples 0-1 and 0-11 were performed at X-Ray Laboratories,
1978.

TABLE 4

Sample No.	A-12	A-13B	A-23	A-32	A-44	A-56	A-65	A-83	A-87a	A-101	A-103
SiO ₂	76.71	78.04	78.11	74.21	77.44	70.28	75.62	69.03	80.16	76.88	77.26
Al ₂ O ₃	12.01	11.80	10.65	11.51	11.69	14.10	11.00	15.12	9.80	12.18	13.32
Fe ₂ O ₃ T	0.92	0.91	1.16	3.53	0.87	3.99	1.63	3.80	1.73	1.09	1.01
MgO	0.00	0.19	0.19	0.00	0.01	0.81	0.21	0.75	0.38	0.04	0.05
CaO	4.77	2.43	2.46	0.26	4.18	3.38	3.79	2.58	1.35	1.03	0.96
Na ₂ O	3.30	4.03	4.37	6.08	4.34	5.25	5.09	6.23	4.34	4.79	5.37
K ₂ O	0.41	1.52	0.23	0.89	0.20	1.11	0.33	1.23	0.32	2.71	1.43
TiO ₂	1.23	0.49	0.70	0.37	0.69	0.92	0.48	0.81	0.31	0.40	0.48
P ₂ O ₅	0.41	0.10	0.16	0.05	0.21	0.28	0.13	0.29	0.07	0.08	0.09
MnO	0.05	0.07	0.02	0.00	0.05	0.11	0.15	0.13	0.04	0.05	0.04
S	0.04	0.01	N.D.	1.16	0.02	0.06	0.00	0.01	0.00	0.01	0.00
L.O.I.	N.D.	N.D.	0.36	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total	99.85	99.59	98.41	98.06	99.70	100.29	98.43	99.98	98.50	99.26	100.01

Table 4: Chemical analyses of silicified mafic volcanic rocks.

Sample locations are found on Fig. 3.

Data of sample A-23 originated from X-Ray Laboratories, Toronto.

<u>Mafic Volcanic Rocks and Gabbro *</u>		<u>Felsic Volcanic Rocks</u>		<u>Silicified Mafic Volcanic Rocks</u>	
<u>Sample No.</u>	<u>L/R</u>	<u>Sample No.</u>	<u>L/R</u>	<u>Sample No.</u>	<u>L/R</u>
A-48	12/V1	A-70	13/V1	★ A-32	16/V-V1
A-48 A	12/V1	A-71	14/V1	A-101	17/V1
A-76	14/V1	A-74	14/V1	A-103	17/V
A-19	16/V1	A-1	19/V1	A-12	18/V1
* A-46	19/V-V1	A-112	19/V	* [A-23	19/V1
A-47	19/V-V1	A-81	19/V	A-44	19/V1
A-60	19/V1	A-80	19/V	A-56	19/V1
A-5e	23/V1	A-80 a	19/V	A-65	19/V1
A-35	24/V1	A-45	19/V1	A-13 b	19/V1
A-37	24/V1	A-14 c	20/V	[A-87	25/V1
A-40	24/V1	A-4	20/V1	+ [A-87 a	25/V1
		A-2	20/V1		
		A-11	23/V1		
		A-118	23/V1		
		A-5	23/V1		
		A-83	24/V1		
		A-84	24/V1		

Table 5: Location by lot and range (L/R) of the chemical analyses presented in Tables 2, 3, and 4 and plotted on Fig. 3. See the Appendix for a brief discussion pertaining to the chemical analyses and for an explanation of those samples denoted by the symbols ★, *, # and +.

volcanics. For this purpose, the chemical data have been plotted on an AFM diagram (Fig. 7) and on FeO vs FeO/MgO and SiO vs. FeO/MgO diagrams (see Figs. 8 and 9, after Miyashiro, 1974). The chemical data also appear on Fig. 10, an alkali plot (after Hughes, 1973) and a TiO_2 vs. SiO_2 diagram (Fig. 11) was constructed.

It will be seen in Table 2 that the mafic volcanic specimens analysed have the composition of andesite, basalt, and rocks intermediate between basalt and andesite.

About half the mafic volcanic samples analysed lie in or close to the "spilitic field" of the alkali plot (Fig. 10), yet these samples were originally considered to be representative of unaltered material. They are texturally and mineralogically well preserved with abundant, fresh-looking plagioclase, however their high content of Na_2O relative to K_2O may point to sea-floor metasomatism of a nature described by Hughes (1973). The erratic alkali content of the mafic volcanics is also reflected in the AFM diagram where most of the "spilitic" analyses⁵ lie in the calc-alkaline field. This diagram must be used with care when one is dealing with a hydrothermally altered volcanic terrain, since most of the mafic volcanics and the rhyolites analysed lie in the tholeiitic fields of Figs. 8 and 9, diagrams which do not consider the alkali

⁵ (Note samples A-65, A-87a, A-23, A-44 and A-12 in Table 4 and AM-1, A-80, A-81 and A-5 in Table 3).

Figure 7: AFM-- $(\text{Na}_2\text{O} + \text{K}_2\text{O}) : (\text{FeO}) : (\text{MgO})$ diagram. ²Tholeiitic (TH)^T - Calc-alkaline (CA) boundary after Irvine and Baragar (1971). Solid circles: unaltered mafic volcanics and gabbro, crosses: felsic volcanics; open circles: silicified mafic volcanics. The same symbols are used also in Figures 8, 9, 10 and 11, and the letter "G" signifies the gabbro analysis.

Figure 8: Plot taken from Miyashiro (1974). Calc-alkaline (CA) and tholeiitic (TH) fields are indicated. Felsic volcanics (+) and silicified mafic volcanic rocks (O) with very high FeO/MgO (see Tables 3 and 4) plot outside the limit of the abscissa.

Figure 9: Plot taken from Miyashiro (1974). Calc-alkaline (CA) and tholeiitic (TH) fields are indicated. Felsic volcanic (+) and silicified mafic volcanic rocks (O) with very high FeO/MgO (see Tables 3 and 4) plot to the right of the top right hand corner of the diagram.

Figure 10 — Alkali plot after Hughes (1973).
The island arc tholeiite field
was incorporated into the dia-
gram by Stauffer et al., (1975).

Figure 11: Plot of SiO_2 vs TiO_2

content of the rocks.

There is a significant chemical "gap" between the most siliceous andesite (62.23% SiO_2) and the rhyolite of lowest silica content (70.09% SiO_2). Many of the rhyolites are extremely siliceous. They too have locally been silicified, and some of the samples were chosen to illustrate that this type of alteration occurs throughout the volcanic succession. More than half of the rhyolite analyses lie outside Hughes' igneous spectrum (Fig. 10), and all but two of these lie in the calcalkaline field of the AFM diagram, yet Figs. 8 and 9 show most of the rhyolites to lie within the tholeiitic field along with the mafic volcanic rocks. Again, these observations indicate that the rhyolites originally had tholeiitic affinities, and that their position in the calc-alkaline field of the AFM diagram reflects metasomatism and not a magmatic trend.

All but one of the silicified, mafic volcanic rocks lie outside the igneous spectrum of the alkali plot, and half of these in the spilite field, strongly indicating them to have distinctly anomalous chemistry for rocks which qualify as rhyolite on the basis of their silica content. Without exception, silicified mafic volcanics lie within the calc-alkaline field of the AFM diagram. Their position is largely a function of a metasomatic process whereby the rocks were markedly depleted in MgO and FeO . At least half the silici-

fied mafic rocks would be considered of calc-alkaline association if viewed in Miyashiro's diagrams, yet the "unaltered" mafic rocks are mainly well within the tholeiitic field of these same chemical plots.

A generally applying chemical feature of the silicified rocks is their high content of TiO_2 relative to rhyolites of comparable silica contents. It will be seen from the chemical plot of TiO_2 vs. SiO_2 (Fig. 11) that the rhyolites exhibit a regular decrease in TiO_2 with increasing SiO_2 content. The silicified mafic volcanic rocks do not exhibit such a regular variation, and at a TiO_2 value of about 0.40%, there is an overlapping relationship with rhyolites containing between 70% and 75% SiO_2 . Where one encounters a siliceous volcanic rock with a TiO_2 content in this "overlap region" of the diagram, a petrographic examination of the particular specimen using textural material previously discussed, commonly will determine it to be rhyolite or silicified mafic volcanic rock.

II.2.5 Intrusive Rocks

1) Diorite-Gabbro (Metadiabase)

The early mafic intrusive rocks form large sill-like bodies which cut all volcanic rocks and postdate all sulphide mineralization at Aldermac. Larger, elongate, plug-like bodies were mapped south of MacKay Lake and in the south-west portion of the map area.

However, without the sub-surface geological information, one can only speculate on their three-dimensional geometry. They are in some instances laterally extensive, as is the intrusion which occupies the MacKay Lake Fault, near the Chance sulphide showing, and extends eastward more than 2 km.

This rock is dominantly very uniform, massive, medium to coarse-grained and equigranular in outcrop. Very locally, large, dark green pyroxene pseudomorphs up to 1 cm across occur in a fine-grained mesostasis. The rock commonly is pale greenish-grey to greenish-brown on weathered surfaces, and has a medium to dark green colour on fresh surfaces.

These intrusions are readily distinguishable from the texturally similar, cross-cutting, late Precambrian diabase dikes. The latter are very fresh-looking and dun-brown weathering rocks, which in thin section exhibit much unaltered pyroxene and plagioclase. In contrast, the feldspar of the older "metadiabase" is greenish-white and completely altered. Epidote is conspicuous in veinlets, a feature one does not see in the unmetamorphosed late diabase.

The colour index of the older gabbro-dioritic rocks varies from about 25 to 40, whereas 45 to 50 is common for the younger dikes.

In thin section, textures are well preserved and the relationship of the mafics and feldspar is best described as in-

tergranular or diabasic. Only rarely was sub-ophitic texture observed. In this case, large pyroxene pseudomorphs, 0.3 to 1.0 cm in size, contain numerous feldspar grains usually less than 1 mm in the largest dimension. One exposure exhibits about 10-15% of these large pseudomorphs set in an intergranular matrix.

The original lath - and blade-shaped plagioclase is completely saussuritized. The mafics are now mainly light green, pleochroic actinolitic amphibole and chlorite. The actinolite has replaced clinopyroxene, as optically continuous patchy remnants of this mineral were observed within large amphibole grains. No orthopyroxene was observed in thin section, although some weathered surfaces exhibit textural and colour variations of the mafics which indicate that there were originally two pyroxenes present. There are patches of interstitial granophyric material and from 1 to 2% of opaques.

A chemical analysis (A-46) is presented in Table 2. It clearly shows these mafic intrusions to have the chemical composition of a tholeiitic basalt. This result is not unlike those obtained from similar rocks studied in the central Noranda area, and discussed immediately below.

Identical rocks have been described from the central Noranda area (e.g. Dufresnoy diorite, Wilson, 1941). Lickus (1965) described some four generations of mafic intrusions occurring at the Vauze mine. It was clear to him and C.D. Spence that

some of these fed spatially associated mafic flows. Chemical studies verified this relation. The large, very coarse-grained "flat diorite" that covers the Vauze deposits is gabbroic in composition. It is representative of very large volumes of basaltic magma which intruded major synvolcanic fracture systems after deposition of the Vauze ore.

Thus, these mafic intrusions occupy fracture systems which probably fed stratigraphically higher effusions, subsequently eroded (Dufresnoy Tholeiitic Series, Dimroth et al., 1973; Gelinas et al., 1977). At Aldermac, they at least partially occupy pre-existing synvolcanic structural discontinuities, for example, the MacKay Lake Fault and a fracture which parallels the late diabase dike on Macanda Hill (Fig. 5). These early fracture systems are very significant in that somewhere along them, there may have been loci of synvolcanic hydrothermal activity and sulphide deposition.

ii) Syenite

This large intrusive complex underlies about half the thesis area presented in Fig. 3. The main body has an elongate geometry and extends in a north-northwest direction for 6 km, with the Aldermac mine at its southern end (Fig. 2).

The complexity of the syenite was first pointed out by H.C. Gunning (1927). The syenite is a plexus of dikes of highly variable texture and colour index. Gunning noted an

earlier phase of very mafic character. This is described as dark green, fine-grained to porphyritic, and in places trachytic. This author's mapping included with the most mafic rocks biotite-rich lamprophyric phases sometimes containing conspicuous magnetite. This rock is found on the south-east border of the intrusion and as isolated dikes removed from the main body. Its relative age within the syenite mass could not be established. The colour index can be as high as 60-70, and thus the field term gabbro has also been used and appears in the map legend (Fig. 3). Successively younger phases are lighter in colour, with feldspar becoming more abundant. Gunning states that the final phases are very leucocratic and composed of feldspar and quartz. This has been observed in the present study and verified by petrographic work. A good example is that of a composite dike where the latest intrusion has a mode of 85% microcline + albite and 10-15% quartz. The remainder is made up of titanite, allanite and opaques. The texture of this specimen is particularly interesting and is exhibited in Plate 30. The earlier dike is also syenite but it is coarser grained, has tabular feldspar phenocrysts, and is distinctly more mafic.

Most exposures of the syenite are spectacularly porphyritic, feldspar phenocrysts being locally so abundant as to make the matrix inconspicuous. The habit of the feldspar is generally tabular, and although the grain size is highly variable, some platy crystals measure over 10 cm across. Commonly

Plate 30 -- Poikilitic texture in syenite. Albite grains are included in large 3.0 mm to 5.0 mm microcline crystals. Albite and quartz compose the interstitial matrix. This is a representative of a late phase of the syenite intrusive complex. Field of view 2.0 cm. Cross-polarized light.

the seriate, tabular K-feldspar occurs in a mauve to dark red-brown, medium-grained to aphanitic groundmass.

The most conspicuous mineral in the groundmass is light green aegirine-augite with acicular habit, but Gunning reported in addition blue amphibole, titanite, apatite, rutile, magnetite, and zircon. He also observed albite, orthoclase, and microperthite, the latter two commonly occurring in trachytoid textured dikes.

The Aldermac syenite body would appear to represent a very high level, sub-volcanic magma reservoir with its associated hypabyssal dikes and plug-like satellites. Syenite dikes show markedly variable trends about the main intrusion and they seem to occupy fractures radial to it, probably produced during the emplacement of this complex. The volcanics immediately east of the syenite face toward this intrusion, opposite to the direction expected if the syenite's emplacement was diapiric. The volcanics also face the small satellite body located north of the Chance showing (see Fig. 3). These observations are considered in some detail in the structural geology section. The syenite intrusions are probably the remnant roots of the youngest Archean volcanic rocks preserved in the Aldermac area. Alkalic volcanics have been described within the Temiskaming Group about 55 km to the west at Kirkland Lake (Cooke and Moorhouse, 1969). Due to the rarity of alkalic volcanism in the Archean record, it appears probable

that the Aldermac syenite is correlative. As yet no absolute age studies have been done on the syenite complex.

iii) Late Diabase

The youngest intrusion at Aldermac is a northerly-trending diabase dike. It can be traced through the syenite porphyry north of the mine where it swings sharply northwest. The dike is best seen on Macanda Hill, where it is locally over 30 m wide.

Besides the obvious cutting relationships, its physical and petrographic characteristics readily distinguish it from the older gabbroic (metadiabase) rocks. Original clinopyroxene and labradorite are preserved.

The dike appears to be displaced about 30 m by the Mac-Kay Lake Fault. However, because it is known to dip 70° west, north of this fault, then the apparent right-hand lateral movement could result from essentially vertical displacement.

II.2.6 Structure

i) Introduction

The structural framework of the Aldermac area is interpreted on the geological map (Fig. 3). The structural complexity is immediately apparent. Faults and lineaments dominate and at first glance, a roughly east-west structural grain predominates. On closer inspection, structural trends

are seen to be divergent throughout the map area. Thus the trends are east-southeast in the western half of the map, but are east-northeast in the central, and northeast in the eastern part of the map. They are again east-southeast in the extreme northeast part of the map. Clearly then, there are a number of structural "domains" which are bounded by faults and major lineaments. These domains are best described as fault blocks within which are yet smaller structural entities (see especially Fig. 5).

That the syenite complex is intimately related to the tectonic setting is best evidenced by the radial pattern of dikes that emanate from it. Faults and lineaments parallel dike orientations throughout the area. Earlier structures cut by syenite dikes, for example the MacKay Lake Fault, are discordant to this pattern.

There is no evidence of penetrative deformation having affected the map area, there being no secondary penetrative fabric in the rocks. This conclusion is supported by petrographic work which has demonstrated that the rocks are texturally very well preserved despite being metamorphosed. Locally the rocks are intensely fractured and/or jointed, but even these orientations are variable, reflecting perhaps some primary jointing, at least locally. As an example, columnar joints are well developed in rhyolite west of the map area (Spence, 1963). Shearing is restricted to features

such as the MacKay Lake Fault and areas marked by chloritic and/or sericitic alteration, where the rocks were more susceptible to deformation. Shearing in the areas of alteration seems to parallel pre-existing structures and to be of very local extent.

The MacKay Lake Fault is part of a regionally significant structure. East of the map area, it is continuous with the Horne Creek and Beauchastel-Area Creek Faults (as shown on the regional map, Fig. 2). The fault is, based on diamond drilling (Hawley, 1948), steeply south-dipping, trending east-northeast, and comes within 450 m of the Aldermac shaft as it traverses the southern part of the map area. It has a very strong expression on $\frac{1}{4}$ mile: 1 inch air photographs. Outcrops near the fault are locally intensely fractured and the fault is very well represented in drill holes W-1 and W-6 (see Fig. 3).

The intimate relationship of the MacKay Lake Fault both to sulphide mineralization (Hawley, 1948) and to a thick, sill-like body of diorite is apparent. The fault is an expression of a structurally weak zone or fracture system, which may have been produced during the construction of the Aldermac volcanic complex. It has since become prominent as a locus of shearing, later than the intrusion of the diorite which in part occupies it.

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ii) Criteria of Stratigraphic Facing

Top determinations were based on several different criteria. These include pillow shapes, grain gradation in well-bedded tuffs and, in one outcrop, the truncation of a markedly discordant feeder-hydrothermal alteration zone against an overlying flow.

Pillow structures are best developed in the extreme eastern portion of the map area, but there are also good exposures within the elongate "trough-shaped" mafic volcanic unit (best seen in Fig. 4), 1 km west of the Aldermac shaft. In this latter area the flows face south, a conclusion drawn on the basis of pillows which is supported by the fining of well-bedded tuffs within these flows. Only a few isolated facing directions were determined in the former area. Thus, structural information gained from pillowed outcrops is quite limited.

Much of the exposed basalt and andesite is not conspicuously pillowed. Structural information is thus usually gained from inter-bedded tuffs, but there are only about a half dozen different localities where grain gradation in these is distinct enough to make any determination.

An exceptional outcrop exhibiting a well defined facing direction occurs approximately 300 m southwest of the Aldermac shaft (see Fig. 5). Here, massive, very locally pillowed andesite grades northward into pillow breccia, succeeded by tuff breccia and finally tuff. A feeder dike in the same outcrop appears to become extrusive in the same direction.

Sympathetic to both these observations, a discordant alteration zone or vent is truncated by a unit of tuff and massive andesite. The indication again is that the sequence faces north.

iii) Marker Horizons

There are no definite marker horizons such as the tuff that occurs at andesite-rhyolite contacts in the central Noranda camp. However, the mafic tuff which crops out approximately 0.8 km west of the Aldermac mine (X₅, North Contact Tuff) may be considered to be an analogous lithology. It shows good potential to be a useful stratigraphic marker on the basis of previous diamond drilling (e.g. Cominco drill hole 73-1, Fig. 3). At Aldermac, there is a possible "marker package" of rocks occurring south of the mine and having an east-west extent of 2 km. This is the QFP sill and possible extrusive equivalents, and the spatially associated altered and mineralized andesitic lavas and fragmental rocks. It is tempting to consider the QFP and associated fragmental rocks exposed near the mine and in the northwest corner of the area to be equivalent.

iv) Interpretation

The geology of the Aldermac area was last interpreted in 1945 by J.W. Ambrose and S.A. Ferguson. Part of their map (Fig. 4) is included so that other possible interpretations may be readily considered. On their map, Ambrose and Ferguson have drawn a broadly arcuate fold axial trace, convex

southward. The structural information at their disposal made this feasible for two reasons:

- a) the east end of their syncline appeared to be a horseshoe-shaped closure, and;
- b) the trough-shaped andesite exposure west of the mine could represent the core of a very gently plunging fold with rhyolite repeated both north and south on the limbs.

A number of recent observations now make this interpretation essentially untenable. These are briefly:

- a) there do not appear to be any north-facing exposures within the andesite "trough" west of the mine;
- b) the eastern closure of the proposed syncline has an apparent steep, westward plunge. The structure is not a simple horseshoe-shaped one as Figure 45 clearly shows. The geometry is not consistent with what appears to be a gentle to horizontal plunge for the structure west of the mine;
- c) neither field work nor petrographic examination of the rocks reveals the slightest trace of a secondarily imposed fabric; i.e. a cleavage or lineation. The rocks are not penetratively deformed, yet the inferred syncline would need to be isoclinal.

The Aldermac terrain is clearly a complexly faulted one where stratigraphic units interfinger, lateral variations are rapid, and there are no definite marker horizons.

There is most definitely deformation at Aldermac, as witnessed by opposed facing directions but a fold axial trace

cannot be defined. What then is the nature of the structure? Our best clue comes from an examination of the geology of Macanda Hill (see the section on the Archibald Prospect and Fig. 5). Here an arcuate structure previously interpreted as a fold seems to consist of rotated fault slices. The structure is "cut off" to the north by an east-west fault. Field evidence, specifically the fact that a rhyolite tuff dike was emplaced along this fault and that this same structure has in part controlled the emplacement of a rhyolite dome, suggests that the rhyolite dome in this locality was emplaced after the deposition and block faulting of the andesite units surrounding it. This means that the structure is in all probability a primary synvolcanic one. On the basis of the intersection of bedding attitudes the structure plunges steeply west, in marked discordance to its attitude west of the mine.

That the Macanda Hill geology may be related to a much larger volcanic structure is supported by other evidence. For instance, the mine sequence faces south (see X₄, Aldermac Mine structural evidence), opposite that established for the "marker package" of rocks only 250 m to the south. Even more convincing evidence than this is the geology of the Chance Showing (Fig. 3). There, the rocks face north and dip in that direction at an angle of 45°. A reversal occurs between there and the mafic volcanic rocks to the north. Field evidence strongly indicates that this reversal must occur in the valley to the north of the Chance. This valley is occupied by a

syenite body, a geometrically complex satellite of the main intrusion. Since this syenite is filling a paleo-fracture system or system of faults, it could be interpreted to be occupying a rift-like structure.

Figures 12 and 13 are cross sections of the Aldermac area drawn to show the structural complexity of the terrain and the relationship of the principal sulphide showings and the Aldermac copper deposit. The cross-sections serve to illustrate the tectonic hypothesis presented in this study.

The passive deformation of a volcano-tectonic structure by block faulting and intrusive activity associated with volcanism better explains the observable structural features and data, than the syncline proposed by J.W. Ambrose et al., (1945).

II.2.7 Metamorphism

The "unaltered" mafic volcanics exhibit the mineral assemblage albite + actinolite + epidote + chlorite + titanite. Quartz and white mica are ubiquitous. These rocks are, except for obvious phenocrysts, extremely fine-grained and possess no discernible secondary fabric. Volcanic textures are beautifully preserved, with microscopic albite crystals mimicking the original microlitic groundmass textures common to andesites and basalts. It is not uncommon to see an alignment of albite microlites which is considered to be a primary characteristic of the mafic flows. Also, clinopyroxene and andesine, as phenocrysts, have locally been preserved.

Figure 12 --- Cross-section (A-B, Fig. 3) of the Aldermac area, showing the relationship of the Chance and North Chance showings and the North Contact Tuff to the structure. The cross-hatching represents zones of fracture-controlled sulphides and magnetite in veins, stringers and joints. The cross-section was constructed by the author utilizing the data of Chance (X_2) drill holes plotted on Fig. 3.

Figure 13 --- Cross-section (C-D, Fig. 3) showing the relationship of the Mackay Lake sulphide zone to the Aldermac mine. Aldermac mine vertical section 9200 E (Fig. 21) has been projected westward. Section was drawn by the author utilizing mine exploration data and drill hole sections (West Wasa Mines Ltd.) for the Mackay Lake zone.

No minerals characteristic of very low grade or the sub-greenschist facies, such as prehnite or pumpellyite (Winkler, 1974), were observed. It appears appropriate to describe the rocks as belonging to the chlorite zone of the greenschist facies of regional metamorphism. This is consistent with W.T. Jolly's metamorphic interpretation (1978) of the Blake River Group immediately west of Noranda.

Areas of chlorite and/or sericite alteration within the volcanics are characterized by textural, and to some extent mineralogical, distinctions. Spotted rock at Aldermac is very similar to that observed associated with the Amulet deposits, although not as well developed. Dalmatianite as it is known at Amulet is a texture produced by porphyroblasts of cordierite-anthophyllite + biotite set in a chlorite + sericite + quartz-rich assemblage. A. de Rosen-Spence (1969) and J.M. Kelly (1975) showed the cordierite-anthophyllite assemblage to postdate volcanogenic sulphide deposits and to have been a product of isochemical contact metamorphism. This metamorphic event occurred during the emplacement of the Du-fault granodiorite stock.

At Aldermac, the analogous texture is defined by chlorite and biotite-rich aggregates (see section entitled Altered Volcanic Rocks) set in a chlorite + sericite + quartz alteration of andesite. Again, field evidence and petrographic work show the "spots" (see Plate 29) to postdate alteration in the volcanics. They may have grown in response to the thermal

event related to the intrusion of the syenite complex.

Contact metamorphism was not investigated in this study. Almandine garnet was observed in fractures in mine dump samples and as 1-2 mm euhedral porphyroblasts in silicified rock of the MacKay Lake showing. This mineral was recently recognized in the Millenbach Mine (personal commun., Gibson, 1978) where it is considered to have a contact metamorphic origin.

The rocks of the Aldermac terrain have been affected by regional and contact metamorphic events. Mineral assemblages observed in the volcanics are varied, and are complicated by virtue of the metasomatism which predated metamorphism. Thus, for example, minerals found in altered zones reflect some primary alteration assemblage which has been upgraded by metamorphism. Calcium rich garnet illustrates this well (Chapter II. 2.3 ii), since unlike epidote it has not been reported in modern geothermal systems and therefore may be inferred to be a product of metamorphism.

CHAPTER III

Economic Geology

There are a number of altered and mineralized zones within the volcanics. These have both historical and economic significance, and will be discussed in chronological order below. This is how they appear on Fig. 3, the original showing being number 1 (X_1) and the most recent discovery number 6 (X_6). Figure 14 is a plan showing the current property boundaries in the Aldermac area.

III.1 X_1 = The Original Showing, The MacKay Lake Prospecti) Description

The maximum surface dimensions of this prominent area of sulphide-stained rocks and gossans are 550 m by 160 m.

Available drilling data show this mineralization to extend as much as 220 m below surface and to be essentially vertical. Data gained from drill holes W-1 and W-6 (shown on Fig. 3) combined with surface mapping indicate stratigraphy to be vertical to steeply north-dipping; thus the mineralized zone appears to be in the gross sense concordant.

Dip needle surveying and trenching revealed two small, heavily mineralized areas (Fig. 15). The sulphides of these, the Nos. 1 and 2 "lenses" were described thus by Cooke et al. (1931; p. 176):

Figure 14: Plan of properties held in the Aldermac area. Drawn for New Inasco Mines Ltd., by C. Authier (1978). Geology taken from Q.D.N.R. compilation map (1962). The main sulphide showings discussed in the text are shown by the crossed pick and hammer symbol with subscript numerals. The Y's indicate the other sulphide showings briefly discussed in the text.

Figure 15 -- Geological map, Aldermac mine (Hawley, 1948). The No. 2 lens is shown within the Mackay Lake Prospect, stippled on Fig. 3.

"The No. 1 showing in this spotted rock is a small shatterzone lying apparently almost flat, and filled with pyrite and some chalcopyrite. It is only about 25 feet across. About 25 feet to the northeast there is another spot of heavy mineralization. The No. 2 showing is about 200 feet to the north. It is a lens traceable on the surface for about 130 feet, and striking due east. The middle two feet of the lens is almost solid sulphides, and the surrounding rock is heavily impregnated with sulphides, throughout a total width of about 15 feet. There is rather more chalcopyrite in this showing than in No. 1."

The No. 2 showing is now recognized by a trench immediately west of the road, about 250 m almost due south of the Aldermac shaft. The material in and around it is very heavily mineralized and carries by far the best chalcopyrite mineralization to be seen anywhere on surface. Polished sections from here reveal the mineralization to include both sphalerite and magnetite, the content of the latter explaining why the No. 2 was discovered as a result of a dip needle survey.

The rusty nature of the exposure makes it very difficult to recognize primary volcanic features or to determine how the sulphides are distributed. The cutting and polishing of many samples was therefore necessary. Pyrite is by far the principal sulphide. It is only very locally seen to be accompanied by conspicuous chalcopyrite. The sulphides occur in amygdules and fractures as well as a fine dissemination throughout. Specimens exhibit at least two generations of fractures, well illustrated by Plates 31, 32, and 33.

Plate 31 -- Altered and mineralized mafic lava of the MacKay Lake Prospect. Silicification has proceeded along original cooling cracks and sulphides were deposited in these fractures. The dark upper part of the sample is biotite rich. Note the spotted texture. This specimen comes from the extreme western edge of the showing, near the road.

Plate 32 -- Silicified and chloritized mafic flow rock from the original Aldermac No. 2 lens (within the MacKay Lake sulphide showing). Note the broadly arcuate cooling (?) fractures in the lava and another crosscutting generation of fractures. Pyrite and chalcopyrite occur in fractures and amygdulæ. The polished slab measures 13 cm across the base.

Plate 33 -- Mineralized breccia from the MacKay Lake Prospect. This is mafic volcanic rock, silicified, chloritized and sericitized as a result of hydrothermal alteration. Sulphides, chlorite and sericite are prevalent in the interstices between grey, siliceous fragments. This rock is very similar to that of the Archibald Prospect subsurface, mineralized zone. This sample was collected about 60 m west of the original No. 2 lens.

The arcuate fractures exhibited in Plate 32 are suggestive of concentric cooling cracks (called "laminations" by de Rosen Spence, 1976) in pillowed lavas which are well displayed elsewhere, outside the MacKay Lake mineralized zone. Some exposures record the highly fractured and brecciated nature of the host volcanics. There can be no doubt the mineralized zone is within mafic lavas and associated breccias.

A number of polished thin sections were examined. These invariably contain trace amounts of very fine-grained chalcopryrite and sphalerite. Rock chips from this showing analysed by New Inesco Mines Limited are anomalous in Cu and Zn. The values obtained range from 82 to 2,220 p.p.m. and from 75 to 13,025 p.p.m. respectively.

The mafic volcanics have been pervasively altered throughout the mineralized zone. Most commonly the rock has a light grey, bleached appearance on fresh surfaces. Here quartz forms the bulk of the rock and the adjective "silicified" best describes this type of alteration, but the minerals chlorite, sericite, biotite, epidote, and garnet are locally prevalent. Patches of chloritized and/or sericitized volcanics give the rock either a dark green or light, creamy-yellow colour. Some areas are rich in biotite and thus black on fresh surfaces. Garnet and epidote are conspicuous in still other areas, as vesicle and fracture fillings in massive, texturally and structurally well-preserved mafic lava.

It was not possible to resolve geometrically the different alteration assemblages into, for example silicified, sericite, chlorite, or biotite zones, as has been done for some of the deposits in the central Noranda camp. There, alteration pipes characteristically have chlorite-rich cores which grade out into sericite-rich altered volcanics (see both Lickus, 1965 and Riverin, 1977). The alteration assemblages are quite varied and appear to be irregularly distributed within the MacKay Lake zone.

ii) Interpretation:

The No. 2 lens is on strike with tuffaceous material both to the east and west. The lens appears to be the lateral equivalent to mafic tuff and tuff breccia, well exposed approximately 180 m to the west. The mineralization is thus interpreted to represent a local small seafloor accumulation of sulphides deposited near the top of pervasively brecciated and mineralized andesite.

To the west, outside the MacKay Lake mineralized zone, the character of the volcanics is best evidenced. An excellent exposure, termed the Sakrison Vent, is depicted in Figure 6. The rocks here represent a discordant fracture system in the volcanics which fed magma to the surface and was also the locus of intense hydrothermal activity.

The andesite (see chemical analysis A-60, Table 2) is only locally massive; most of the exposure is best described

as pillow breccia and tuff breccia. As shown in Figure 6, the succession appears to fine northward, from massive and weakly pillowed lava at the base through pillow breccia and tuff breccia to massive tuff at the top. The whole is covered by a massive, silicified mafic flow. This succession is reminiscent of pillow breccias described by D. Carlisle (1963).

The succession described above truncates a discordant zone of intense silicification (refer to chemical analysis A-65, Table 4 and Fig. 3). Tuff occurring at the same stratigraphic position as the top of this discordant zone contains silicified andesite blocks. Field relations indicate that this silicified zone is cut by a spotted, chloritized mafic dike. The overlying tuff breccia also is very chloritic.

The stratigraphic relationships shown in Figure 6 are complex, and indicative of a paleovent. Plate 34 provides sound evidence that extrusive and hydrothermal activity overlapped, adding a further element of complexity. Only minor sulphides occur at the top of the silicified zone but the laterally equivalent rocks of the MacKay Lake Prospect are heavily mineralized. The subsurface orientation and character of these mineralized and altered zones is not known, and this can only be appreciated by exploratory drilling. Seafloor accumulations of sulphides occur at the surface in the MacKay Lake zone and may exist elsewhere at depth. For example, at the bottom of drill hole W-6, a QFP unit hosts a high

Plate 34 — Silicified fragments in pillow breccia at the Sakrison Vent (see Fig. 6). The silicification predated the extrusion of the mafic lava encompassing these altered fragments. This pillow breccia originated from a spatially associated feeder dike, substantiating that magma extrusion and hydrothermal activity overlapped. Lens cap is 5 cm across.

proportion of mineralized andesite and silicified andesite fragments. The QFP may be extrusive at this elevation, 410 m vertically below surface.

III.2 X₂ The Chance

This showing is named after the syndicate which originally held a group of claims containing what is now recognized as the Chance property. In 1923, when the first serious prospecting, stripping, and trenching was being done, the Chance was only one of some 15 veins or individual prospects being examined. Most of these, it appears, were silicified zones in the volcanics, but MacKay (1923, Chance Syndicate company files) also reported persistent low gold values and molybdenite at contacts between syenite and the volcanics.

The Chance is the most important of these mineralized zones, and was subjected to the most exploratory work. It lies approximately 1,100 m west-south-west of the Aldermac shaft, adjacent to the township centre line (Fig. 3).

The mineralization lies wholly within volcanic rock. The showing was remapped by the author during August, 1978, after a grid had been established with 32 m (100 ft) line spacings and stations at 16 m intervals along the lines. The resulting map is presented as Fig. 16.

1) Geology of the Chance Deposit

The geology of the showing is varied and presents a challenge to interpretation, particularly in the area of the heaviest mineralization. H.C. Cooke et al., (1931, p. 222) des-

Figure 16 --- Geology of the Chance prospect. This map area is outlined on Fig. 3. The legend of Fig. 3 applies to this figure. Cross-hatching represents areas where joints are filled with sulphides, magnetite, and quartz. The old exploration pits and surrounding excavated rock are shown in the upper central portion of the map.

cribed the host country rocks to be light-coloured, hard, rhyolite lavas interstratified with beds of breccia. They go on to say (p. 222): "two of the flows cut by the vein-like band of ore are respectively 60 and 80 feet thick; the three beds of breccia with which these flows are interbanded are 15, 32, and 18 feet thick. The beds strike north 62 degrees east and dip steeply north." The "vein" of ore, as it is referred to in the old reports, "is composed almost wholly of pyrite, with some magnetite toward the edges." It was reported to strike about 105° and therefore cuts bedding at an angle of 45° . The thickness of semi-massive sulphides is said to have varied from 1 to 2 m (3-6 ft) in massive rhyolite to up to 10 m (30 ft) in the breccia bands.

It is useful to present this earlier description of the Chance, as it is not now possible to examine in detail the water-filled pits. Also, material excavated from these pits covers a good deal of the heavily mineralized zone, and the rocks are sulphide-stained away from the pits (4a.1, Fig. 16).

The most recent field work, presented here, shows the Chance showing to have approximate dimensions of 250 m by 100 m. Within this area, pyrite fills minute and megascopic fractures and well developed joints, and is locally heavily disseminated in light grey to cream-coloured siliceous vol-

canics (see chemical analyses A-32, A-101, Table 4). Much of this rock is silicified andesite intercalated with well bedded mafic tuff (Plate 35) and tuff breccia, one horizon of which contains silicified fragments. A stratiform body of QFP is exposed immediately southeast of the pits. It is massive, homogenous, and identical to the QFP sill south of the Aldermac mine. However, a tuff at its north contact contains blocks of QFP, suggesting that the body was extrusive. If so, a perplexing fact is that the QFP appears to be unaltered, while the surrounding country rocks are intensely metasomatized. There may have been two generations of QFP and in this case the sill-like body could post-date mineralization.

The attitude of the stratigraphy appears to be well established. On surface, the tuffaceous horizons dip from 40° to 60° north and face north (Fig. 16). Their attitude and upright disposition are substantiated by Cominco drill hole 73-4, the core of which displayed grain gradation in tuffaceous rocks (Wallis, 1973). Thus, the Chance mineralization is strikingly discordant to its host volcanics.

The Chance mineralized zone is cut by gabbro (metadiabase) and by post-gabbro syenite dikes.

11) Alteration and Mineralization

Silicified rock envelops the area of heaviest mineralization which itself is characterized by intense sericitiza-

Plate 35 -- Bedded mafic tuff of the Chance showing. Note that some layers appear to be more siliceous and have a thinly laminated appearance (near the top of the polished slab) Height of the specimen is 15 cm.

tion. Polished thin sections reveal chlorite and biotite to be locally significant, in some instances defining spots. Chlorite also fills veinlets in some specimens examined.

The mineralization is spectacular, with massive pyrite and magnetite blocks conspicuous on waste piles around the pits. The massive sulphide is fine-grained, from 0.2 to about 1 mm, and distinctly granular with fine, saccharoidal silica as the principal gangue. Some of the mineralization has a vuggy appearance due to weathering and contains clusters of pyrite cubes over 1 cm across. These large sulphide crystals are cemented together by very fine-grained silica.

Chalcopyrite was seen in only a few rock samples although it was in the past reported to be significant (Chance Syndicate company files). Sphalerite was noted, primarily in magnetite-rich specimens, occurring as veinlets, discontinuous bands, or disseminations. An assay done on a barren-looking massive magnetite specimen returned 4,400 p.p.m. zinc. Grab samples from pits in the area of the best mineralization have assayed as high as 1.7% zinc and 1.6% copper (Wallis, 1973). Many pyritic, barren-looking samples contain extremely fine-grained (microscopic), disseminated sphalerite.

The sulphide-oxide zone has been described as having the gross form of a vein. This generalization may apply to the zone delineated by a line of trenches which appear to have explored the most massive mineralization. The trenches

are on a linear feature which parallels the foliated sericitic host rocks. However, much of the mineralization occupies intensely fractured, bleached, chalky weathering rock. The resulting geometry is suggestive of polygonal joints filled with pyrite, magnetite, quartz, and chlorite. Plate 36 exhibits a very good example of this structure; the exposure occurs immediately north of the large, centrally located pits. About 30 m to the west-southwest, a pit exposure shows almost massive pyrite outlining very siliceous, cherty polygonal blocks (sample A-101, Table 4) and smaller fragments.

The diamond drilling done in the past gives a good impression of the vertical extent and nature of the Chance mineralized zone. These holes are plotted on Fig. 3. Holes C-1, C-2, and C-7 pass through the sulphide zone. Hole C-1 is in mineralization for a core length of 104 m (343 ft), described by Smith (1927, Chance Syndicate company files) as "a heavily mineralized zone of disseminated pyrite which in places showed narrow bands of massive pyrite from $\frac{1}{2}$ " to 2" wide". It also showed scattered specks of chalcopyrite, sphalerite, and magnetite. This hole gave the best results, but in that none of the holes intersected massive sulphides of any appreciable width, it appears as though the best copper and zinc mineralization occurs on surface. This is supported by hole D-1 (Fig. 3), which undercut the zone 180 m (600 ft) vertically below surface. Thus, the Chance appears to be a vertical zone of heavily disseminated and fracture-controlled pyrite, magne-

Plate 36 -- Polygonal fractures in siliceous volcanic rock of the Chance showing are occupied by magnetite, pyrite, chlorite and quartz.

ite, quartz, chlorite, and sericite. Where the mineralization decreases outside this zone, the rock is intensely fractured and has been described as coarsely brecciated.

iii) Interpretation

The Chance Prospect has a complex geological setting. Reference to Fig. 3 shows the host rocks to have an intricate faulting history as recorded by gabbro and syenite dikes. In addition, they are intensely altered. Both east of the Chance and just south of the MacKay Lake fault, the rocks have been pervasively silicified. Sericite and chlorite are well developed only in the immediate area of the showing (Fig. 16).

A gabbro (metadiabase) dike which postdates the Chance mineralization bounds it to the south. This dike fills a synvolcanic structure, the MacKay Lake fault, and itself may represent a feeder to stratigraphically higher, now eroded, flows. It attests to the block faulted nature of the volcanics, and provides indirect evidence that the Chance mineralized fracture system is synvolcanic.

The available data show the Chance to be roughly equivalent to thick and, locally, heavily mineralized pyrite-magnetite-rich, tuffaceous units encountered at depth in D.D.H. 73-4. The sulphides and magnetite occur in a markedly discordant fracture system and are associated with intense sericitization and local chloritization. The most plausible ex-

planation is that the Chance is the erosional remnant of an hydrothermal system that produced stratiform, massive sulphide-oxide deposits. That is, it represents the lower, epigenetic stringer alteration pipe portion, which channelled solutions up to the syngenetic, seafloor accumulations. The massive pyrite and magnetite mineralization is indicative of a seafloor volcanic orifice.

III.3 X₃ The North Chance

What is referred to here as the North Chance sulphide showing occurs 370 m north-northwest of the Chance Prospect. The showing is bounded to the south and west by syenite and to the north by an interpreted fault (see cross-section, Fig. 12).

The gossaned and stained siliceous volcanics here have been known for as long as those of the Chance Prospect. Pyrite occurs disseminated and in fractures in silicified zones in what have been described as "veins" or "shears". In one old pit, trace amounts of chalcopyrite were found along with very local massive pyrite and pyrrhotite mineralization.

In 1926, this area of mineralization was tested by a single drill hole, C-3 (Fig. 3). This hole was designed to test the downward extension of the best surface mineralization, which is now marked by a row of small pits. The core from this hole was mineralized from 160 m to 190 m (500 ft to 593 ft), a vertical depth of approximately 90 m (300 ft), and re-

portedly carried "heavy" pyrite over the last 4 m (13ft) of this section (Chance Syndicate company files). Accompanying the pyrite were a few specks of chalcopyrite, sphalerite, pyrrhotite, magnetite, and graphite. The mineralization appears to have been both disseminated and in fracture fillings. The drill hole data were plotted and the best mineralization lies vertically below the surface mineralized zone marked by the pits.

There are no records of any work having been done on the North Chance Showing between 1927 and 1972. In the latter year, Cominco had an option agreement on the Chance Property which is now known as the Geophysical Engineering Property. Cominco conducted ground geophysical, geochemical, and geological surveys and drilled one hole (72-1) that year (Wallis, 1973). Further mapping and geochemical work were carried out in 1973. Litho-geochemical analyses for Cu, Zn, and Hg were done on "bimodal" breccia matrix (see Plate 2) and tuff samples. The geochemical work outlined an area of zinc enrichment, defined by those samples with > 200 p.p.m. Zn. It has an east-west strike and extends from near the tuff tested by D.D.H. 72-1 in an easterly direction for about 250 m. Diamond drill holes 73-1, -2, and -3 (Fig. 3) were placed to test this geochemical anomaly, and the sulphide-bearing tuff (North Contact Tuff) to the north. A total of 80 samples from the core were analysed for Cu and Zn. They support the 1972 surface results, indicating that the altered volcanics

are anomalous in Zn. Equally important was the structural-stratigraphic information gained by the drilling (see Fig. 12).

The most recent mapping, done on this showing by the writer in 1976 and 1978 shows that:

- a) most of the siliceous rocks are silicified mafic volcanic rocks; garnet, calcite and epidote are locally conspicuous;
- b) the rocks are pervasively fractured and intruded by a multitude of diorite and syenite dikes;
- c) silicified volcanics are in fault contact with unaltered andesite, as the Cominco drilling indicated.

The rocks hosting the North Chance mineralization belong to a fault block which is delineated by faults and by the syenite body bounding it to the south and west. Its structural discordance is evident in the structural cross-section (Fig. 12).

III.4 X₄ The Aldermac Mine

The Aldermac Copper deposit was a discovery credited to geophysics, the first in the history of the Noranda mining camp (Boldy, 1977). It underlay low, swampy ground as shown in the Frontispiece. Its discovery is historically interesting in that the property was originally staked, during the early winter months of 1923, because of its location adjacent to a syenite intrusion (see Fig. 15).

1) Geology of the Deposit

J.E. Hawley (1948) described the orebodies as being contained in a series of Keewatin tuffs and agglomerates that are interbedded with rhyolite flows. Figures 17, 18, 19, 20, and 21 are taken from Hawley's report and from Noranda Explorations Limited company files. Figure 21 is particularly instructive for stratigraphic and structural information.

An attempt to map in detail the exposures near the mine met with only limited success. A very large exposure forms a hill 125 m west of, and on strike with, the deposits (see Frontispiece). Unfortunately, because of wind-blown pyrite concentrates, much of the outcrop is stained, which, combined with moderate to intense silicification and chloritization, makes it almost impossible to decipher the geology.

As shown on Fig. 3, a salient geological feature is a QFP body, well represented in D.D.H. W-4 (Fig. 3) where it is seen to be largely fragmental in nature. Rhyolite flows, tuffs and breccias, and andesite and its silicified equivalent occur immediately west of the QFP body. This tuff is undoubtedly the lateral equivalent of the fragmental rocks to the east which hosted the orebodies. It is rich in quartz eyes and siliceous rock fragments. Pyrite is the only conspicuous sulphide in hand specimens, but polished sections reveal in addition very fine-grained disseminated pyrrhotite, sphalerite, and chalcopryrite. In addition, very thin films of chalcopryrite were noted on some fracture surfaces.

Figure 17 -- Plans of levels, Aldermac Mine (Hawley, 1948).

Figure 18 -- Vertical section, S42° E, Aldermac mine (Hawley, 1948).

Figure 19 ▲ Plan of No. 4 level, showing relations of ore to interpreted folding, Aldermac mine (Hawley, 1948).

Figure 20 -- Plan of the 8th level, Aldermac mine (provided by Noranda Explorations Ltd.)

Figure 21 -- Vertical section, 9200 E through the Aldermac mine.
Fig. 20 shows the location of this section. View east. Section provided by Noranda Explorations Ltd.

Mining operations at Aldermac ceased in October, 1943, thus an attempt at describing the host rocks depends heavily upon written reports, and a thorough examination of the waste dumps. Salient on the dumps are:

- a) massive, structureless, black siliceous lava carrying variable amounts of veinlet epidote and conspicuous light-coloured garnet. This was referred to as massive rhyolite flows by past geologists;
 - b) very siliceous, quartz-feldspar porphyritic, cream-to dark-grey-coloured fragmentals; tuff breccia and breccia. Some siliceous fragments are aphyric. This rock is probably what is referred to as agglomerate in the old reports;
 - c) crudely bedded to finely laminated sulphide and magnetite bearing lapilli tuff, tuff, and cherty tuff (exhalite).
- Plate 37 shows an example of slump folded, brecciated and banded magnetite and quartz-rich material which resembles chert (80-90% silica). Most tuffaceous samples carry a significant proportion of quartz and feldspar crystals and crystal fragments, siliceous rock fragments and a variable proportion of chlorite, sericite, and very minor amounts of biotite.

Mine plans and sections show tuff to be the predominant host to the ore.

The "mine stratigraphy" is intruded by myriad dikes and sills of many generations, including diorite, felsite, feldspar

Plate 37 -- Two examples of tuff from the Aldermac mine. Top specimen has some sphalerite-rich layers (S), conspicuous quartz crystals and quartz-porphyrific rock fragments. Bottom specimen is slump folded, extremely siliceous (cherty) laminated tuff (exhalite). The dark grey layers are magnetite-rich.

porphyry, lamprophyre, and diabase. Mine plans show these to have predominantly north and northwest trends.

The structure of the deposit is shown in Figures 17 to 21 inclusive. As depicted in these plans and sections, the orebodies strike roughly east, dip 60° south in the upper part of the mine, and are vertical in the lower part of the mine. For the purposes of mining, the deposit as a whole was treated as a vertical, chimney-like structure. The sulphide masses were hosted by siliceous tuffs, breccias, and massive flows which dip uniformly south at approximately 70° . Thrust faulting caused displacement of the ore such that it appears to plunge steeply east (see Hawley, 1948; p. 727).

Nowhere in the literature is there any mention of top determinations within the mine succession, although the Aldermac deposit is stated to occur on the north limb of the syncline (Hawley, 1948). It is clear from the discussion of the structure of the area (Chapter II) that the existence of a simple synclinal structure is improbable.

An examination of the geology (Fig. 3) from Mackay Lake northward to the deposit and the syenite intrusion leads one to at first suspect that the succession is homoclinal. However, a structural cross-section (Fig. 13) shows a marked discordance approximately 100 m south of the shaft. This section was drawn up where there is information from diamond drilling. The rocks south of the mine are vertical or dip steeply north and face north, while the mine stratigraphy

dips 70° S and appears to face south. With regard to the mine area, original tops can only be inferred, but several different lines of evidence are consistent. These are:

- a) as first pointed out by J.A. Dresser and T.C. Dennis (1949), the sulphide lenses in part truncate tuff and agglomerate layers (see Fig. 21, mine section 9200E). This discordance results from the cross-sectional arcuate form of, for example, No. 4 orebody, which suggests that the sulphides have locally assumed topographically positive, dome-like geometry. This feature is also seen in some of the deposits in central Noranda, where orebodies such as the Millenbach, Lower "A", and Vauze, to name a few, have an intimate relation to submarine rhyolite lava domes;
- b) there is a quartz-feldspar porphyritic, fragmental rhyolite exposed immediately northwest of the shaft. It is thick and perhaps quite extensive since the bottom portion of D.D. H. W-4 records about 200 m of similar rhyolite. Rhyolite tuff, in part hosting the ore, carries abundant quartz and feldspar phenocrysts and these may have derived from the QFP body. This body appears to be intimately related to the sulphide masses;
- c) E.L. Bruce (1933) logged and studied drill hole intersections through the Nos. 3 and 4 orebodies. His observations indicate that the stringer-type mineralization occurred on the north margin of the sulphide lenses (personal commun., J.A. Ayer, 1978).

Although the ore carried appreciable amounts of sphaler-

ite, there is no mention of its distribution within the ore. Thus, there is no information regarding metal zoning which might lead to further inference regarding the stratigraphic facing direction.

The above points are mutually supportive, indicating that host rocks and ore young to the south. A fault is drawn in Fig. 13 to explain the break in structural continuity. This fault, if it exists, must be masked at surface somehow, as it is not apparent from surface mapping. It may now be represented by the intensely silicified rock cropping out, about 80 m north of the collar of D.D.H. W-4, and/or in part be occupied by later intrusive material of felsic composition. The exact nature of the discontinuity is subject to speculation, but in a block-faulted terrain such as is postulated in the Aldermac area, there may be an explanation. The Aldermac mine is bounded on three sides by syenite. The entire mine package of rocks may represent a fault block that was tilted during the intrusion of this syenite mass. This is not inconceivable when the attitudes of what are here considered structural blocks, located south of the Aldermac deposit are examined (refer to Fig. 3). The MacKay Lake sulphide zone and the associated, discordant alteration zone, the Sakrisson Vent (Fig. 6), are contained in steeply dipping to vertical strata. The Chance sulphide zone occurs 650 m to the west within stratigraphy which is inclined 45° - 60° north. A prominent north-south lineament (Fig. 3, 100 m east of the road) sepa-

rates these two sulphide showings, and both are bounded to the north and south by faults and intrusions. The showings belong to distinct structural entities or fault blocks which assumed their relative attitudes before the emplacement of the subvolcanic diorite sill which in part occupies the MacKay Lake fault. The fact that this diorite body is not displaced by the north-south lineament lends support to the notion that the observed structural variations were produced during the volcanic evolution of the area.

The Aldermac ore deposit, by lying within a distinct fault and intrusion-bounded block, bears no direct relationship to the MacKay Lake sulphide zone. The two may however be temporally equivalent, in that both are volcanogenic.

ii) The Orebodies

The deposit consisted of three major lenses (Nos. 3, 4, 5; Fig. 17) of massive sulphides and several small, uneconomic, isolated pods. The vertical extent of the orebodies was considerably greater than their maximum strike length. The relative locations and geometry of the orebodies can be visualized by inspection of Figures 17 to 21 inclusive (a mine model photograph is found in Hawley's 1948 paper, p. 727). The massive sulphide lenses had a close spatial relationship, extending one beneath the other to the bottom levels of the mine. They rake steeply to the east, a feature partly due to a thrust fault which displaced the largest orebody.

All three bodies had mineable quantities of chalcopyrite. Sphalerite is also reported and is abundant on the dumps, but nothing is known of its abundance or distribution in the orebodies. The tailings are reported to assay as much as 2% Zn (personal commun., D. Hume, 1976).

Orebody No. 3

This body was an elongate, roughly east-west trending, south-dipping lens. Its maximum dimensions in plan view were 85 m by 10 m. It extended to within 10 m of surface, and tapered out just below the 500 ft level. E.L. Bruce (1933) reports the tonnage to have been about 220,000, with an average grade of 2.68% copper.

Pyrrhotite was the predominant sulphide, forming the bulk of the central part of the sulphide mass. Pyrite formed the outside edges and the orebody graded out into pyritiferous siliceous, fragmental rocks. Chalcopyrite was distributed as irregular veinlets or stringers and larger masses cutting both pyrrhotite and pyrite. Magnetite was also reported (Cooke et al., 1931).

The No. 3 lens occurred within what is described as a rhyolite breccia. This breccia was extremely siliceous, the fragments said to resemble quartzite. This fragmental unit as it is traced from the western edge into the orebody becomes increasingly mineralized, pyrite being disseminated

and occupying veinlets along with chlorite and hornblende (Cooke et al., 1931, p. 180). The ore and breccia were reportedly contained within hard, massive rhyolite lavas.

Orebody No. 4

This sulphide mass lay vertically beneath No. 3, accounting for its discovery as the shaft was being sunk. It dipped more steeply southward than No. 3, and was vertical between the 4th and the 9th, bottom level, of the mine. This body constituted the bulk of the ore mined. Its greatest dimensions were on the 1,125 foot level (Fig. 21) where it had a length of 95 m and a maximum width of 57 m. The tonnage between a depth of 80 m and 230 m was estimated at 1,017,960 (Bruce, 1933). The average content of copper was 1.65% and silver 0.5 ounces per ton. At that time, the value of the gold in the ore was 40 cents per ton (0.02 oz/ton).

Between the 6th and 7th levels, the No. 4 orebody was displaced by a low angle, thrust fault. The portion below the fault is called the No. 6 orebody in mine reports (Bruce, 1933). Although the tonnage of the faulted extension of the No. 4 was very large, the ore was low grade. Mining was carried on only to the 8th level (1,250 ft) despite the persistence of massive sulphides to the 450 m (1,400 ft) elevation. Here, the orebody passed into disseminated sulphides in a chloritic alteration zone in tuffs and agglomerates (Hawley, 1948).

The main constituent of the ore was pyrite, with a minor amount of pyrrhotite and chalcopyrite. The latter two sulphides commonly occurred in vein-like bodies with chalcopyrite reportedly forming the margins and pyrrhotite the centre. Chalcopyrite also occurred in small veinlets.

Orebody No. 5

There is very little information available on this orebody. It was, like the No. 3, lens-like in character, extending almost vertically from the 140 m to the 330 m (440 to 1,035 ft) elevation. Widths ranged from 3 m to 13 m, lengths from 10 m to 45 m. It was partially below the No. 3 and slightly south and east of the main No. 4 orebody. The No. 5 was the smallest orebody, perhaps in the order of 100,000 tons. The copper content is not reported.

iii) Physical Characteristics and Petrography of the Ore

The majority of massive sulphide samples from the mine dump consist of granular (0.2 to 2.0 mm) pyrite with or without other megascopically visible sulphide phases. In polished sections of this material, the pyrite forms equant subhedral to buckshot-shaped grains, and chalcopyrite is interstitial to pyrite, but many examples were noted where it forms veinlets, blebs, and patches. Pyrrhotite occurs as anhedral polygonized grains, but also as minute veinlets and magnetite forms equant, submillimetre grains disseminated throughout the ore.

Sphalerite is commonly very finely disseminated if present, but has been observed in veinlets with chalcopyrite and pyrrhotite. The chief gangue mineral in the massive pyritic material is quartz which has a finely granular, sugary aspect in silica-rich specimens. Quartz is fine-grained, anhedral, and commonly occurs as granoblastic aggregates. It is highly variable in abundance and can be subequal in proportion to the total sulphides present. Other gangue minerals commonly observed in the ore are calcite, epidote, titanite, amphibole, sericite, and chlorite. The amphibole occurs as either acicular tremolite or subhedral prisms exhibiting clear tremolitic cores and actinolitic reaction rims.

The majority of dump material is massive and of very uniform texture; however, where sphalerite is abundant, it defines coarser grained diffuse lenticles, wisps, and distinct layers (see Plate 38). Sphalerite-rich layers commonly do not exceed 1 to 2 cm in thickness. Some pyrite layers in "banded" ore are noticeably chalcopyrite-rich. The layering may be a primary depositional feature: this has been considered to be the case for very similar-looking ore in the Millenbach deposit, occurring at the stratigraphic top of sulphide lenses (Simmons et al., 1973).

There are notable exceptions to the above statements concerning texture and structure. Pyrrhotite-rich specimens are commonly coarse-grained and exhibit very large (> 1 cm) porphyroblasts of pyrite. In these specimens chalcopyrite and

Plate 38 -- Layered sphalerite bearing massive sulphides from the Aldermac waste dumps.

pyrrhotite are intimately related and interstitial to the much larger pyrite grains. Chalcopyrite is invariably most abundant (ore grade material) in the pyrrhotite-rich samples.

Massive magnetite was also noted on the waste dumps. This mineral has also been observed by the author crudely interlayered with sphalerite; pyrrhotite, pyrite, and chalcopyrite occur throughout this latter example and textural relations of the sulphides are complex.

The variation in texture and grain size of the massive ore samples is notable; however it is not possible to determine the spatial relations of this variability in orebodies which have long been mined out.

Stringer-type mineralization is very rarely observed on the waste dumps. The Aldermac examples consist of intensely silicified, featureless rock which is cut by a complex network of sulphide veins and veinlets. Pyrrhotite and pyrite define veins up to 2 cm across, but chalcopyrite is conspicuous in the smaller scale veins. The total effect is analogous to that of tree roots and their much smaller rootlets. This type of mineralization is probably what E.L. Bruce (1933) referred to as ore "quartzite" which occurred in the immediate footwall to the massive sulphide lenses. It also seems probable that this is the sort of rock that he reported from his examination of Aldermac drill core.

The sulphide assemblage constituting the Aldermac orebodies was pyrite + pyrrhotite with much lesser amounts of chalcopyrite + sphalerite. Magnetite also appears to have been a significant component of the ores. The abundance and structure of zinc-rich ore, although not previously reported, is a significant feature and reminiscent of the Millenbach massive sulphide lenses.

iv) Alteration

The nature of the alteration, i.e. the alteration assemblages and their geometry, is not well understood since no such study was undertaken during the life of the mine. Thus, for example, it is not possible to talk about alteration pipes and their mineralogical zoning, as has been done for deposits at Noranda. Stringer-type mineralization and attendant alteration is recorded in Aldermac drill hole data, and there are good examples on the mine dumps. The most common type consists of pyrite stringers in a mosaic of quartz with some sericite and chlorite. Biotite and fresh albite were in the past also considered important alteration minerals. Tremolite is conspicuous in some polished sections of the ore and tuffaceous rocks. The mineral chloritoid was recognized in one magnetite-rich specimen found on the waste dumps.

The breccias occurring near the No. 3 orebody were said to resemble quartzite (Bruce, 1933), and the matrix to the

"quartzite" breccia fragments was said to be highly chloritic and sulphide-bearing. Earlier studies at Aldermac recognized what was described as intense silicification immediately to the west, on strike with the deposit. The original nature of the rock is largely obscured; it is cut by chlorite veinlets. Most previous workers believed chloritization and sulphide deposition to be intimately related, and to have followed the silicification episode.

Both epidote and garnet are not uncommon in the altered rhyolite flows and breccias. They typically occur together as bleached veinlet-like features. Both are interpreted as metamorphic products of rock metasomatized at the time of ore deposition. Plate 39 represents a sample of QF₁ which has been pervasively fractured and epidotized to produce a pseudo-breccia, interpreted to be a product of intense hydrothermal activity.

v) Summary

The Aldermac copper deposit was of the proximal volcanogenic type. A number of lenses of pyrite and pyrrhotite-rich massive sulphide were intimately intercalated with rhyolite fragmentals and flows. The geometry of the lenses, and the nature of the alteration associated with these, suggest an origin consistent with that documented for deposits in the central Noranda mining camp. The Millenbach deposit (Simmons et al., 1973) could be considered analogous. There, many

Plate 39 -- Pseudobreccia from Aldermac waste dump. Believed to have been produced by intense alteration of QFP fragmental rock with in situ brecciation. Epidote and garnet are conspicuous in the vein-like parts.

massive sulphide pods, lenses, and cone-shaped bodies rest on an extensive, ridge-like QFP extrusion. The deposits are products of intense hydrothermal activity and have mineralized discordant zones or alteration pipes directly beneath them. The orebodies occupy tuffaceous horizons which are laterally extensive and are considered useful as markers.

Differences in the geology observed between the Millenbach and Aldermac can be ascribed to variations on a volcanic theme. At Aldermac, the tuffaceous rocks are distinct in that they appear to be anomalously thick, quartz crystal-bearing, and intercalated with QFP breccia and magnetite-rich, cherty layers (see Plates 8 and 37). Andesitic flows do not overlie the orebodies as they do at Millenbach. The structural setting of the two deposits is quite different in that at Millenbach the succession is shallow dipping and monoclinial, although neither has been penetratively deformed.

The weight of available evidence indicates one other important conclusion. The Aldermac deposit does not bear a direct relation to the MacKay Lake sulphide zone; they occur on either side of a structural discontinuity, the nature of which is speculative.

III.5 X₅ North Contact Tuff

This tuffaceous horizon crops out 200 m north of the collar of D.D.H. 72-1 (Fig. 3). It is well exposed in a

135

small pit where it is about 0.3 m thick and mineralized with pyrite.

Its name derives from the fact that the tuff occurs at a "rhyolite" - andesite contact. Tuffaceous material at this contact crops out in only two other places along strike as far as 1 km to the west. However, thin, impersistent horizons are found within the overlying andesite flows and at the top of these near the Horne Fault Mines property boundary (Fig. 3). The tuff is variable in character on surface, and consists of interlayered mafic and very fine-grained, siliceous (feldspathic) ash beds. The latter may show graded bedding in layers which vary from 0.5 to 3.0 cm. Pyrite is conspicuous and very finely disseminated so that the tuff is commonly rusty-weathering. Several samples of this tuff were collected and assayed, the highest values obtained being 670 p.p.m. Cu and 1,970 p.p.m. Zn.

The North Contact tuff was first treated as a bonside exploration target in 1962. The ground was then being worked by the Consolidated Zinc Corporation (Beauchance Mines Limited) which was primarily interested in the main Chance zone (X₂) and the Gan Copper property (off the northwest corner of Fig. 3).

At this time, exploration geologists working in volcanic terrains such as Noranda were beginning to consider massive sulphide deposits in a new light. It was gradually becoming

fashionable to view them as coeval with their associated volcanics, or syngenetic. Thus, it is quite possible that C.D. Spence had the newly discovered Vauze deposit in mind when he spotted holes B-23 and B-24. He wanted to test the andesite-rhyolite contact in the vicinity of a postulated domal structure (in the rhyolite) and a strong N17° E lineament (see Fig. 3). The structure however, was not as expected and the andesite appears to pinch out quickly. Sheared, layered tuff was encountered both within the andesite and at the rhyolite contact. It was described by C.D. Spence as very well mineralized in hole B-23, containing visible chalcopyrite. The best assay-return was 0.15% Cu over 1.5 m.

No further drilling was done, and it was to be 10 years before Cominco worked the same ground under an option agreement (see Table 1). Diamond drill holes 73-1 and 73-2 both intersected the contact tuff. The former encountered interbedded cherty and mafic tuff intercalated with andesite over a core length of 6.5 m. Some of this tuff was estimated to , carry up to 25% pyrite, although 5-20% was the norm (Wallis, 1973). At 350 m (1,102 ft) near the top of the intersection (220 m vertically), the tuff analysed 1,200 p.p.m. Cu and 325 p.p.m. Zn over 0.05 m. The next best assay was 400 p.p.m. Cu and 300 p.p.m. Zn over 1.6 m.

◆
Hole 73-2 cut short sections of tuffaceous rock from 165 m (514 ft) to 265 m (829 ft) where the rhyolite contact was encountered. Most of this interval was anomalously high in Cu and Zn.

A Cu value of 810 p.p.m. was reported at 200 m (633 ft) and near the rhyolite contact, three samples showed Cu and Zn to run as high as 2,250 p.p.m. and 1,100 p.p.m. respectively.

In summary, there is pyritiferous tuff intermittently exposed at the rhyolite-andesite contact over a distance of 1 km. Its persistence along this contact at depth has been demonstrated by a very limited amount of drilling. Also, the fact that this horizon has been found to be locally thick and to carry up to 25% pyrite and to be anomalously high in base metals is significant.

The geology of the North Contact tuff east of C.D. Spence's N17° E lineament is strongly reminiscent of that near the Amulet "C" deposit. This latter deposit occurs at a silicified andesite (Amulet "Rhyolite") - andesite contact and has laterally equivalent pyritic tuff-sinter.

If the geology at Aldermac can be considered analogous to that of the Amulet area, then undoubtedly the North Contact tuff represents a legitimate exploration target. It may be a difficult one to assess however, because of the possibly large areal extent of this horizon.

III.6 X₆ The Archibald Prospect

The Archibald Prospect occurs approximately 600 m east of the Aldermac shaft, within a topographic feature which has been named, by the author, Macanda Hill. It was named after

the option formerly recognized as Macanda Copper, which in 1977 was amalgamated with the old West Wasa property and re-named West Macanda Resources (see Fig. 14).

The surficial geology on Macanda Hill in the immediate area of the Archibald Prospect is characterized by mafic fragmental rocks, particularly isolated pillow breccia (Carlisle, 1963), and massive and pillowed flows. Tuff and tuff breccia horizons are intercalated with the aforementioned rocks. Within these rocks there is local pyrite mineralization occurring as narrow, 1-2 mm, fracture fillings, but in one area (diagonally ruled in Fig. 5) the rocks contain 1-2% of very fine-grained disseminated pyrite. However, here it is not the sulphide which is conspicuous, but rather the chloritic, locally spotted nature of the volcanics. Thinly bedded, rusty-weathering tuff is the only obvious sulphide-bearing lithology within the area of chloritic dalmatianite-textured rock. The altered nature and texture of the rock on Macanda Hill had in the past attracted attention, and in the late 1960's two holes were drilled (B-24, B-25; Fig. 5).

Interesting mineralization was first encountered in diamond drill hole B-24, an existing hole, deepened by G. Archibald in December, 1975. The target was a geological one, namely bedded, siliceous tuff south of the altered mafic volcanics, near the north edge of what is now interpreted to be a rhyolite dome.

Significant mineralized sections were encountered in drilling subsequent to the B-24 intersection. In all, seven holes have been drilled. The best intersections to date were obtained in holes M76-2, M77-1, and M77-3. These indicate a vertical mineralized zone which has now been tested to a vertical depth of about 250 m. Its surface projection in part coincides with an area of no outcrop. Its thickness varies from 15 to 30 m on plotted sections. However, the strike and rake, if any, of the sulphide-bearing zone is unknown. It appears that it may trend east-west and plunge steeply, if vertical projections to surface are correct. It is not known what relation the mineralization in B-24 has to that of the other holes (M76-1, M76-2, M77-1, M77-2 and M77-3, Fig. 5).

i) Description of Mineralization

In drill core, the mineralized zone generally has a bleached, light grey to creamy-coloured appearance. However, the rock is only moderately bleached and epidotized in D.D.H. M77-3, with 5-10% uniformly distributed pyrite over the mineralized section. In most other holes, the mineralization, largely pyrite, is impressive, constituting 25-40% of the rock from 125 m to 135 m (390-431 ft) in M76-1. Sulphide occurs both as very fine disseminations and in amygdules in siliceous fragments composed largely of quartz and sericite with minor chlorite. The matrix to these fragments commonly comprises quartz and coarser-grained pyrite. The best mineral-

ization resembles pyrite-rich, siliceous (subequal pyrite and quartz) material examined on the mine waste dumps. In this material, 1-2 mm anhedral-subhedral grains of pyrite are set in a mosaic of quartz. Stringers of chalcopyrite, some 5 mm across occur throughout the D.D.H. M76-2 mineralized section. Even where chalcopyrite is not evident in the core, copper assays run as high as 875 p.p.m. This metal assayed 1,058 p.p.m. over a core length of 30 m throughout the M76-2 intersection, and zinc returned 560 p.p.m. over the same core length. The highest zinc assay was 5,400 p.p.m. over 1.6 m length in hole M77-3. Sphalerite is however not conspicuous and is very finely disseminated as it is in the MacKay Lake zone.

The mineralized zone was, during the initial core-logging, considered to be a tuff breccia horizon. A re-examination of the core indicates that the host rocks are predominantly intensely fractured and altered andesites. The "tuff breccia" seems to be largely a product of in situ brecciation and is pseudobreccia, and therefore not pyroclastic in origin. This in situ brecciation was attended by hydrothermal alteration and mineralization. The mineralized zone is contained within pillow breccias and associated hyaloclastite and tuff. The geology of the Sakrisson Vent (Fig. 6) is viewed as an analogue. In fact, the overall characteristics of both the Archibald Prospect and the MacKay Lake zone indicate they are very similar and perhaps approximate lateral equivalents.

ii) Geology

The detailed surface geology of the area encompassing the Archibald Prospect as depicted in Fig. 5 is complex. Some of the mafic units can be traced for 200 m, and they describe an arc which terminates abruptly at an, interpreted east-west trending fault. This fault is marked by a zone of intense alteration in the volcanics and defines the northern contact of the rhyolite dome (see detailed geology, Chapter II.2.3). There is an elongate exposure of quartz-rich pumiceous tuff east of this dome. It truncates andesitic strata and is affected by the same fault. As noted above (Chapter II.2.3.) field relations and petrographic evidence indicate this body to be a rhyolite tuff dike, a rarely observed feature of Archean terrains.

There are no definite top determinations for the area shown in Fig. 5, but the volcanics west of the diabase dike face north. Crudely layered mafic tuff east of the rhyolite dome shows grain gradation which indicates it faces west. The rocks immediately hosting the Archibald Prospect sulphides give no indication of which way they face, but well bedded, tuffaceous rocks about 60 m to the south exhibit what may be interpreted to be scour and fill structures which indicate a southerly younging direction.

It appears as though the emplacement of the rhyolite dome and the pyroclastic dike was in part controlled by an

east-trending fault. Structural and textural features within the dome strongly indicate that its east and south boundaries face toward the mafic volcanics. This is demonstrated by a traceable unit of QFP tephra and crumple breccia (see Fig. 5) and the mafic volcanic rocks which contain neither cognate fragments of rhyolite nor any intercalated layers of rhyolitic composition.

On the basis of field relations, the rhyolite dome and coeval QFP dikes, sills, and tuff dike are somewhat younger than the mafic volcanics. The latter are now represented by a number of fault-bounded blocks. Internally, some of these blocks show extensive evidence of synvolcanic brecciation and alteration (silicification and epidotization).

It is quite conceivable then that the Archibald mineralization event preceded or was partially coincident with rhyolite dome emplacement. This implies that the mafic blocks east and south of the dome may also contain sulphide deposits. This possibility must be entertained when the Archibald Prospect is re-evaluated in the future.

III.7 Other Sulphide Showings

In addition to the occurrences described above, there are two other interesting sulphide showings (see Fig. 14). One of these is located in the extreme southwestern portion of Fig. 3. Here a thin, persistent, sulphide-rich tuff horizon extends for over 200 m, defining the contact of a quartz-

feldspar porphyritic (QFP) tuff breccia unit with a siliceous, glassy rhyolite flow. C.D. Spence mapped this mineralization in 1963, while Consolidated Zinc Corporation held an option on the ground, historically known as the Odyne and Lagace Option.

It appears as though this showing never aroused much interest. It seems to be completely devoid of base metal; this impression was further substantiated by an assay of massive pyrite (from the tuff horizon) which indicated only 50 p.p.m. Cu and 64 p.p.m. Zn. This showing occurs in a rather isolated outcrop area. The Chance Prospect is 1,100 m to the east across a broad, swampy area underlain by clay and organic-rich soil.

One can only speculate as to how this sulphide horizon, lying within rhyolitic extrusions, relates to the other well-known, previously explored prospects. However, the rhyolite units involved are very similar to those underlying the north-western portion of the study area (see Plate 8).

About 1.5 km west-northwest of the aforementioned mineralization and over 4 km west of Macanda Hill is yet another altered and mineralized zone in the volcanics. This also occurs in rhyolite flows and fragmental rocks, which locally exhibit well developed columnar jointing (see geological map by Spence, 1963; in QDNR assessment files). These felsic volcanics are considered by the author to stratigraphically over-

lie the North Contact Tuff and its intercalated mafic flows.

The rocks are stained and zones of gossan are very locally developed within an irregularly shaped area, 125 m by 160 m. The mineralization is irregularly distributed, occurring in fractures and as finely disseminated sulphide in sericite and chlorite-rich volcanics. There are a number of trenches which reveal the mineralization to consist predominantly of pyrite and pyrrhotite, but chalcopyrite, sphalerite, and galena were observed in areas of the best mineralization. Base metals are not at all conspicuous, and nowhere can the sulphides be described as massive.

Spence's map indicates that nine vertical holes were drilled to test the surface showing. Most holes were started within or immediately peripheral to the surface stain zone. Only two holes appear to have been drilled for the express purpose of gaining stratigraphic information. Spence reports that there were some 65 m to 95 m (200-300 ft) of unbroken core sections of weak mineralization similar to that mapped on the surface. Base metal was reported to have been observed in most holes; however the highest core assays performed returned only 500 p.p.m. Cu and less Zn.

The property containing the two showings just described is now recognized as the Horne Fault Mines, West Group (Fig. 3). It represents the western extension of the Aldermac structure. Numerous sulphide zones and a past-producing

mine characterize the volcanics in the eastern portion of this structure. By contrast, very little is known of the terrain to the west, especially north of the township centre line (Fig. 3). This is closely related to the fact that the amount of rock exposure is much less and the known showings not as interesting as those closer to the Aldermac Mine.

III.8 Summary

The geology of the Aldermac terrain reflects a regionally extensive, synvolcanic mineralization event or events, to which the abundance of sulphide showings, some spectacular, attests. However, only one economic deposit of sulphide is known. The circumstances remind one of the Amulet area. Both the Amulet Upper "A" and Amulet "C" deposits were, in 1925, discovered by their associated gossans (Boldy, 1977). The Amulet "F", occurring 1.5 km to the north of the "C" deposit, was a fortuitous drilling discovery. It was not until 1966 that true, geologically designed drilling resulted in the discovery of the Millenbach deposit. By analogy, the Aldermac area enjoys a status of understanding equivalent to that of the Amulet area in the late 1920's. Thus, the discovery of the Archibald Prospect in 1976 can be likened to that of the Amulet "F" deposit in 1929.

CHAPTER IV

Discussion and ConclusionsA. Stratigraphy and Structure

The stratigraphic succession in the Aldermac area comprises a chemically bimodal suite of intercalated mafic (basaltic to andesitic) and rhyolite flows, pyroclastics and related subvolcanic intrusions. These are cut by gabbro and syenite, intrusions which were attendant to different stages of Archean volcanism and by later, post-Archean, diabase dikes. Regional metamorphism attained lower greenschist facies but the rocks lack penetrative deformation.

Volcanic rocks without conspicuous hydrothermal alteration are of tholeiitic affinity and the mafic rocks are markedly enriched in Na_2O , suggesting seafloor metasomatism.

Stratigraphic facing is demonstrated by some pillowed mafic flows, but more often by grain-gradation in well-bedded tuffaceous rock (exhalite) intercalated with these flows. Further structural information of this nature was furnished firstly by the relationship of a mafic feeder dike to a pillow breccia unit, secondly by the truncation of a discordant hydrothermal alteration zone against bedded pyroclastics, and thirdly by the dome-like geometry of a massive sulphide lens at the old Aldermac mine. In addition, stringer-type mineralization is believed to have occurred on the north

margin of the major sulphide lenses comprising this deposit.

The opposed facing of the succession from place to place is now well established and this cannot be explained by folding. Rather, the area consists of a number of fault blocks. Some faults have been intruded by rocks either chemically or physically similar to those of the volcanic succession, indicating these faults to be synvolcanic. Examples are the sill-like gabbro body which occupies, in part, the MacKay Lake Fault, and the rhyolite tuff dike on Macanda Hill which trends subparallel to this fault. Fault blocks have been rotated relative to one another and it is suggested that the block hosting the Aldermac deposit was rotated during the emplacement of the syenite.

B. Hydrothermal Alteration

Much of the siliceous rock previously identified as rhyolite has been shown to be silicified mafic volcanics. This conclusion has been substantiated by textural criteria based on petrographic work used in conjunction with chemical characteristics of these rocks.

Silicified mafic volcanic rocks either envelop or lie stratigraphically below sulphidic zones. For example, at one location, known as the Sakrison Vent, a discordant zone of intensely silicified rock marks a synvolcanic locus of hydrothermal activity. Also, silicified mafic fragments in breccia units were derived from vent zones such as this,

further demonstrating synvolcanic hydrothermal alteration at Aldermac.

Chlorite and sericite are only locally concentrated in areas of alteration. These minerals have a more direct relationship to mineralization, just as they are known to have in the Amulet area.

Epidote, calcite and calcic garnet-enriched zones in the volcanics bear a close spatial relationship to known sulphide occurrences at Aldermac. Work done to date indicates that alteration zones where these minerals are prevalent slightly predate overlapping zones of silicification. The three minerals represent a metamorphic product of metasomatized basalt-andesite and rhyolite alike, and as such are indicators of hydrothermal activity. Their presence in the rocks could be significant to future exploration, particularly when assessing diamond drill core.

The chemical work presented shows the marked tholeiitic character of most of the analysed mafic volcanics and rhyolites; however, many of the silicified mafic volcanics lie in the calc-alkaline field of conventional geochemical plots. In the AFM diagram these same silicified rocks lie, without exception, in the calc-alkaline field. Clearly, diagrams such as this must be used with care when dealing with a hydrothermally altered volcanic terrain. In general, the silicified mafic volcanic rocks have a higher content of

TiO₂ relative to rhyolites of comparable silica contents.

C. Mineral Deposits

The deposits of the Aldermac area are generally similar to many known volcanogenic massive sulphide deposits by virtue of their association with rhyolite domes, bedded pyroclastics and siliceous exhalite. In addition, hydrothermal alteration is a salient feature of the rocks and chlorite and sericite are intimately related to sulphide deposits. Pyrite and pyrrhotite-rich ores of copper at the old mine carried appreciable amounts of zinc and anomalously high quantities of magnetite. The geometry and internal textures and structures of the Aldermac ore lenses are strongly reminiscent of those of typical massive sulphide deposits. In summing up the mineral deposits at Aldermac, the following points are emphasized:

- i) firstly, the Aldermac copper deposit is an excellent example of what has been termed a proximal volcanogenic deposit. A number of sulphide lenses bore an intimate relationship to a QFP dome, associated fragmentals, and volcanic exhalative sediments which may have emanated from this extrusive body. The Millenbach and Vauze deposits have analogous geologic settings;
- ii) the Aldermac deposit represents but one of a number of sulphide-rich zones in the volcanics, albeit the only one

economically exploited. Sulphide showings are known for a strike length of over 4 km, from Macanda Hill west to a point 1,100 m west of the Geophysical Engineering/Horne Fault Mines Limited (West Group) property boundary;

iii) important accumulations of sulphide occur in mafic and felsic volcanics alike. The sulphides are intimately related to both the structural and stratigraphic development of the volcanic terrain: they are clearly volcanogenic.

The geologic setting of the Aldermac deposit is extremely complex. It reflects a history of intermittent faulting and extrusive and intrusive activity such as one would expect to find at an active volcanic centre. The setting is best visualized as a submarine, graben-like structure or elongate, trough-shaped caldera.

During the life of this structure, intense hydrothermal activity must have predominated at one or more stages in order to produce a number of widely-spaced sulphide occurrences. A better understanding of the place of mineralization in the structural-stratigraphic record at Aldermac must await a patient, deliberate drilling programme. The area must be viewed in a historical perspective, considering that it has taken over fifty years to begin to comprehend the setting of the well-known deposits at Noranda. The potential of the Aldermac terrain to produce another economic massive sulphide deposit is great and presents an exciting challenge.

11. Summary of Geologic History

The Archean geologic setting or "stage" for volcanic activity at Aldermac is illustrated in a series of cartoons, Figures 22a, b, c. These cartoons are intended to help the reader visualize the possible structural development of the volcanic terrain throughout the preserved Archean geologic record.

The earliest volcanics are a texturally and structurally variable suite of rhyolite flows and domes which locally interfinger with massive and pillowed andesite and basalt. These rocks were hydrothermally altered, most notably silicified, and this form of alteration has a close genetic relationship to the sulphide deposits of the area, produced during a quiescent period when extrusive activity was minimal. At the stage of massive sulphide deposition, an observer may have seen a block faulted terrain with a central, medial depression. In this environment, hydrothermal activity would have been focused along step-faults such as the MacKay Lake fault as well as along other fracture systems discordant to this structure.

Extrusion of rhyolite followed sulphide deposition with the formation of post-ore domes and tephra cones.

Dikes and sills of gabbro, some regionally extensive,

Figure 22a -- Rhyolite dome with associated sulphide lenses formed within a volcano-tectonic depression on the sea-floor.

Figure 22b -- Post-ore events included rotation of fault blocks, rhyolite extrusion and inundation of the terrain by basaltic lava.

Figure 22c -- The last recorded Archean volcanic event is indicated here (left-hand side of the cartoon) by the svenite intrusive complex which fed lava to build edifices on the eroded basaltic lava shields. The horizontal dashed line (S-"S") indicates the present erosion surface.

record a basaltic eruptive event, which postdated the aforementioned and which inundated the terrain and may have built shield volcanoes.

The svenite intrusive complex signifies the latest preserved Archean volcanic event of the Aldermac area. The emplacement of the svenite caused regional tumescence and may have rotated the fault block containing the Aldermac deposit to its present steep attitude.

It is difficult to assess what role the Kenoran Orogeny played in the structural evolution of the Aldermac area, but it may have caused some compression of the terrain without penetratively deforming the rocks.

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Appendix

Aldermac Chemical Analyses

The chemical analyses presented with this study are the only ones from the Aldermac area which have been documented and located (see Fig. 3 and Tables 2, 3, 4, and 5).

The purpose of doing a limited amount of chemical work was twofold:

- i) to characterize the "unaltered" volcanic rocks of the area;
- ii) to examine the chemistry of the silicified mafic volcanic rocks and then by comparison with the unaltered mafic volcanics assess this type of metasomatism.

There are good examples of silicification at Aldermac where it is possible to see silicification superimposed upon mafic lava. This "outcrop control" was combined with petrographic criteria; for example, the size, shape and abundance of amygdules and ground-mass textures of siliceous volcanic rocks. Microclitic texture is only well developed in silicified mafic rocks and never encountered in rhyolite. This fact enabled the author to select a suite of known silicified rocks so that their chemistry might be compared to rhyolite in the hope that the altered mafic rock

might still have a "chemical signature".

In general, representative, fist-sized pieces of rock were chosen for analyses. These were free of weathered surfaces and in the case of the mafic volcanics free of conspicuous alteration, e.g. chlorite and/or sericite and quartz. However, despite precautionary measures sample A-60 reveals in thin section incipient "mottle" silicification, despite appearing unaltered when it was collected.

All rock samples were crushed and powdered by J. Stevenson who used the facilities of Carleton University. R. Hartrey of the University of Ottawa made fused pellets and performed the chemical analyses on an XRF apparatus which employs a Phillips 1410/20/AHP X-ray spectrometer. The standards used were either "in house" G.S.C. or internationally recognised ones. An estimate of precision and accuracy may be obtained from the duplicate analysis of sample GT-13 (provided by H.L. Gibson) and the analysis of G.S.C. reference standard LU1 (Table 6).

Some analyses presented in Tables 2,3 and 4 were performed at X-Ray Laboratories, Toronto in 1978. These were also performed by the method of X-ray fluorescence.

Note the following, referred to in Table 5:

- ★ A-32 sample chosen as a representative of silicified mafic volcanic rock but may actually be altered rhyolite.

- * [A-23 two samples of silicified mafic volcanic
A-44 rock chosen from different areas within
a 2 m long "patch" of alteration.
- + [A-87 two samples chosen from the same mafic
A-87a flow or flow-unit, one unaltered, the
other silicified (A-87a).

Table 6 — Duplicate and Reference analyses

Sample no.		GT-13	Dupl.	LU1 (1)	STD. (2)
Wt. %	SiO ₂	74.08	73.32	49.98	49.13
	Al ₂ O ₃	12.42	12.35	15.41	15.62
	Fe ₂ O ₃	3.60	3.53	8.86	9.16
	MgO	1.14	1.10	4.02	4.26
	CaO	0.96	0.96	10.38	10.36
	Na ₂ O	5.12	4.93	1.99	1.97
	K ₂ O	1.23	1.22	0.48	0.43
	TiO ₂	0.52	0.52	0.72	0.76
	P ₂ O ₅	0.13	0.14	0.06	0.08
	MnO	0.11	0.11	0.19	0.19
	S	0.20	0.18	0.03	0.09
PPM	Ba	209	213	246	234
	Cr	0	0	20	8
	Zr	182	177	39	63
	Sr	48	56	163	168
	Rb	11	16	13	15
	Zn	10	7	79	104
	Cu	36	24	37	95
	Ni	5	0	29	50
Total		99.56	98.42	92.21	92.10

(1) Ottawa University analysis of LU1

(2) Analysis of LU1 provided by J.M.
Franklin

Table 7 -- Summary of petrographic observations relating to those volcanic rocks chemically analysed and appearing in Tables 2, 3 and 4.

This table is comprised of the 5 pages immediately following.

Symbols and abbreviations used in Table 7:

X - principal constituent ($>5\%$)
 x - minor constituent ($1-5\%$)
 Tr - trace constituent ($<1\%$)
 ? - presence suspected
 Nos. are used with x to denote the % phenocrysts.

micr. - albite microlites / microlitic
 g.m. - groundmass
 miclmphtic - microglomeroporphyritic
 v. - very
 fn. - fine
 gr. - grained
 dk. - dark
 crse. - coarse
 ave. - average
 e.g. - for example
 interg. - intergrowth

Act. - Actinolite
 Ab. - Albite
 Ep. - Epidote
 Chl. - Chlorite
 Qtz. - Quartz
 Ser. - Sericite
 Tit. - Titanite
 Op. - Opaques
 Gar. - Garnet
 Carb. - Carbonate
 Pyx. - Pyroxene
 Amph. - Amphibole

PLATY VOLCANICS

Sample Number	Minerals Identified														Aegirides	Textures and/or Structures	
	Groundmass							Phenocrysts									
	Pl	Qtz	Chl	Tr	Py	Il	Sp	Pl	Qtz	Chl	Tr	Py	Il	Sp	%	Composition	General Comments
A-5e	X	X	X	X	X	X	X	X	X	X	X	X	X	X	12	X X X	Micr. show 1:10 width:length and swallowtail terminations and comprise 10% of g.m. which is extremely fn.gr.
A-19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1-2	X X	Intergranular to subophitic - subporphyritic.
A-35	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1-2	X X X	G.m. is extremely fn.gr. matte of micr., mafic, and opaque. Most mafic phenocrysts now uraninite (see Plate 5).
A-37	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Tr	X X	Intergranular g.m. phenos < 1mm long.
A-40	X	X	X	X	X	X	X	X	X	X	X	X	X	X			Microclitic to intergranular, crude alignment of micr.
A-46	X	X	X	X	X	X	X	X	X	X	X	X	X	X			Intergranular - subophitic, local patches of interstitial granophyre.
A-47	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2	X X X	Micaphitic, with v. fn.gr. micr. g.m. is dk. and rich in opaque material.
A-48	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4	X X X	Intergranular, some microlites. In general crse.gr. compared to other flows.
A-48a	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Tr	X	Subophitic, feldspar laths ave. 0.3 mm long but up to 0.6 mm.
A-60	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4	X X X	Microclitic, silica occurs throughout g.m. recording incipient albitification.
A-76	X	X	X	X	X	X	X	X	X	X	X	X	X	X	2	X X X	Subophitic, local micaphitic. This is a relatively crse.gr. flow with feldspar laths ave. 0.3mm.
A-87	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Tr	X	Stubby micr., in contrast to e.g., A-5e, Qtz in g.m. v. conspicuous.

2

RHYOLITES

Sample Number	Minerals Identified															Textures and/or Structures
	Groundmass										Phenocrysts					
	Act	Ab	Or	Qtz	Tr	Pl	Py	Amph	Qtz		%	Comp	Act	Py	Qtz	
AM-1	x	x	x	x	x	x	x	x	x	x	Tr	x	Y			Microscopic intgr. of qtz and feldspar with sutured fr. bound. Qtz "even" eye. 0.1 mm. Ep. forms veinlets and patches. Texturally similar to AM-1 with larger 0.1mm patches of qtz. Some t.s. exhibit 0.1mm qtz eyes.
A-1	x	x	x	x	x	x	x	x	x	x	3	x	x	x		Extremely fn.gr. intergrowth of qtz and feldspar with consp. larger qtz patches. Ep. concentrated in veinlets and patches.
A-2	x	x	x	x	x	x	x	x	x	x	1	x	x	x		Like A-2 these samples from the same map unit.
A-4	Tr	x	x	x	x	x	x	x	x	x	2	x	x	x		V. fn.gr. intergrowth or matte of qtz. and feldspar with larger patches of sutured and polygonized qtz.
A-5	Tr	x	x	x	x	x	x	x	x	x	Tr	x				Microphryitic - qtz. eyes and stubby feldspar crystals. The K.M. in A.V. fn. matte of qtz. and feldspar with patches of sutured qtz. (see Plate 17).
A-11	Tr	x	x	x	x	x	x	x	x	x	1	x	x	x		Felted K.M. texture with relatively large patches of silica throughout - silicified. Feldspar crystals ave. 0.5mm.
A-14c	Tr	x	x	x	x	x	x	x	x	x	Tr	x				Microphtic, euhedral-subhedral crystals. Fairly typical K.M. texture for many Alder-mac rhyolites; see Plate 15.
A-25	x	x	x	x	x	x	x	x	x	x	Tr	x	x	x		Qtz. eyes, euhedral-subhedral feldspar. G.M. v. fn.gr. mineralogy uncertain. See Plate 18.
A-70																

Sample Number	Minerals Identified										Assemblage	Textures and/or Structures
	Pl	Qtz	Ab	An	Di	En	Fs	Gr	Py	Il		
A-71	?	X	Tr	X	Tr	X						Texturally similar to A-70 however porphyritic nature not as well developed.
A-74	?	X	Tr	X	Tr	Tr						Regged resorbed qtz. phenocrysts. Up to 10% phenocrysts (Ab. + Qtz.) in a v. fn. gr. intergrowth of qtz. and ab., locally reminiscent of felted texture.
A-80	X	Tr	X	Tr	Tr	Tr						Resorbed feldspar crystals and migmatitic texture salient. V. fn. gr. intergrowth of qtz. and feldspar with patches of qtz. with sutured grain boundaries throughout g.m.
A-80a	X	Tr	X	Tr	Tr	Tr						Flow banded - brecciated. Significant proportion of feldspar is sericitized.
A-81	X	Tr	X	Tr	Tr	Tr					Tr X	Stubby ab. phenocrysts are prominent with only a few qtz. eyes noted. G.m. is coarser grained than most other rhyolites with well developed spherulites throughout a mosaic of polygonal as well as sutured qtz. grains (see Plate 16). This sample appears to be silicified.
A-84	?	X	X	X	X	Tr	Tr					Porphyritic and flow banded (see Plate 19). Feldspar is noticeably sericitized.
A-112m	Tr	X	X	X	Tr	Tr					Tr	Felted texture, reminiscent of some silicified basalt but note chemistry in Table 3.

HYDROLYZED

Sample Number	Minerals Identified													Textures and/or Structures				
	Groundmass																	
	Act	Ab	Bp	Chl	Qtz	Ser	Tit	Op	Car	Carb	Ab	Pyx	Ampb		Qtz			
A-10																		
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
O-1																		
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
O-11																		
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

Composition													General Comments
Carb	Car	Act	Chl	Bp	Qtz								
													Regged grains and patches of qtz. in a v. fn.gr. qtz.-feldspar + sericite G.m. A few anhedral ab. grains noted. This is a texturally atypical specimen. The ep. and carb. are concentrated in veinlets and large patches. Car. occurs only in these features.
													Flow banded, defined by concentrations of amygdules. Perlitic structure well developed in layers without amygdules. Extremely flat - elongated amygdules define a fabric. The G.m. is extremely fn.gr. with sericite throughout. See Plate 14.
													Qtz. rich "haloes" around amygdules and patchy, remnant-like nature of chlorite suggest silicification of this rock. G.m. too fn.gr. to discriminate minerals.

MINERALOGY

Regged grains and patches of qtz. in a v. fn.gr. qtz.-feldspar + sericite G.m. A few anhedral ab. grains noted. This is a texturally atypical specimen. The ep. and carb. are concentrated in veinlets and large patches. Car. occurs only in these features.

Flow banded, defined by concentrations of amygdulites. Pelitic structure well developed in layers without amygdulites. Extremely flat - elongated amygdulites define a fabric. The G.m. is extremely fn.gr. with sericite throughout. See Plate 14.

Qtz. rich "haloes" around amygdulites and patchy, remnant-like nature of chlorite suggest silicification of this rock. G.m. too fn.gr. to discriminate minerals.

SILICIFIED KAPIC VOLCANICS

Sample Number	Minerals Identified												Textures and/or Structures
	Groundmass												
	Act	An	Ab	Tr	Qtz	Pl	Py	Amph	Qtz	%	Amygdules		General Comments
											Comp	Pos	
A-12	X	?	X	X	X	X	X	Tr		15	X		Well developed micr. texture with crude alignment of micr. V. fn. gr. tit. occurs in K.M. grains much smaller than micr. See Plate 24.
A-13b	X	X						X		10	X	Tr TrTr	Micr. texture well developed, also micro-porphyrific. Some phenocrysts replaced by qtz. V. fn. acicular act. in K.M. with micr. and qtz.
A-23 A-44	?	X	Tr	X	?	X		X		5	X	Tr	Micr. texture but not well developed. O.M. v. fn. gr. but ep. occurs throughout. Car. + ep. + carb. rich amygdules in A-44.
A-32	X	Tr	X		X					15	X		Reminiscent of micr. texture but also similar to that of A-12a. Pyrite the dominant op. mineral.
A-56	TrX	X	Tr	X	Tr	?	Tr			2	X	X	Well developed micr. texture. This is conspicuously epidotised lava, from the same flow as A-23 and A-44.
A-83	X	X	TrX	X	Tr	X		X					Abundant stubby micr.
A-87a	?	X	TrTr	X	Tr	TrTr		X	X				Micr. texture with ab. phenocrysts.
A-65	?	X	X	Tr	X	?	Tr			15	X	Tr TrTr	V. well developed micr. texture with stubby ab. phenocrysts. See Plate 25.
A-101	?	X	TrTr	X	?	X		X	3	1	X		Texturally more like rhyolite than silicified mafic volcanics - v. atypical.
A-103	?	X	X	Tr	X	X	?	Tr	2				Poorly developed micr. texture.

General Comments

Well developed micr. texture with crude alignment of micr. V. fn. fr. tit. occurs in K.M. grains much smaller than micr. See Plate 2a.

Micr. texture well developed, also micro-porphritic. Some phenocrysts replaced by Qtz. V. fn. acicular act. in K.M. with micr. and Qtz.

Micr. texture but not well developed. O.M. v. fn. fr. but ep. occurs throughout. Car. + ep. + carb. rich amydules in A-44.

Reminiscent of micr. texture but also similar to that of A-112a. Pyrite the dominant op. mineral.

Well developed micr. texture. This is conspicuously epidotized lava, from the same flow as A-23 and A-44.

Abundant stubby micr.

Micr. texture with ab. phenocrysts.

V. well developed micr. texture with stubby ab. phenocrysts. See Plate 22.

Texturally more like rhyolite than silicified mafic volcanics - v. atypical.

Poorly developed micr. texture.

R A N G E V I I

LOT 11

LOT 12

LOT 13

LOT 14

GROUP)

(WEST)

LTD.

MINES

LEGEND

8	Diabase
7	Syenite
7 L	Lamprophyre, gabbro
6	Diorite - Gabbro, metadiabase
5	Altered, siliceous volcanics, original composition unknown
4	Mafic volcanics, unsubdivided
4 1	Pillow lava
4 2	Isolated and broken pillow breccia
4 3	Tuff breccia
4 4	Massive lava
4 5	Mafic tuff, may include some laminated siliceous material
3	Felsic volcanics, unsubdivided
3 1	Massive, homogeneous, quartz - feldspar porphyritic
3 2	Flow laminated and/or autobrecciated $\pm$ quartz phenocrysts
3 3	Blocky breccia, tuff breccia; quartz and feldspar phenocrysts conspicuous
3 4	Bedded, siliceous tuff
3 5	Massive tuff, quartz 'eyes' conspicuous

MODIFIERS

a	Weak or incipient silicification
aa	Intensely silicified
b	Vesicular (amygdaloidal)
e	Feldspar phenocrysts
F	Feeder dike
g	Mafic phenocrysts
i	Intensely fractured and/or jointed
j	Sulphide(s) in vesicles (amygdules)
k	Pyrite in pillow selvages
l	Sulphide(s) in fractures
L	Laminated (e.g. concentric, cooling cracks)
Lm	Sulphide(s) in laminations (cooling fractures)

52

SULPHIDE SHOWINGS AND PROSPECTS

- 1 MacKay Lake Prospect
- 2 The Chance
- 3 North Chance
- 4 Aldermac Mine
- 5 North Contact Tuff
- 6 Archibald Prospect

PROP	DD
TECK CORP (GEO ENG)	C- B- 72
WEST MACANDA RESOURCES	W B- M- M

6 of 1

DDH LEGEND

DDH #	DRILLED BY	YEAR
C-1	Chance Syndicate	1926-27
B-1	Beauchance Mines	1952-62
72,73-1	Cominco	1972-73
W-1	New Insko	1974-75
B-24,25 (Deepened)	"	1975-76
M-76-1	"	1976
M-77-1	"	1977

GEOI
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4 of 1

GEOLOGY OF THE ALDERMAC AREA NORANDA, QUÉBEC

80%

SOURCES OF INFORMATION

Grid maps, diamond drill logs and reports by: Chance Syndicate, 1923-27, R C J Edwards and C D Spence, 1958-63, C.S. Wallis, 1972-73; H C Sakison, and G Archibald, 1974-77; A D Hunter, 1976 and 1978

J. W. Ambrose and S. A Ferguson, G. S. C. paper 45-17, maps 45-17 A, B, published 1945.

J E. Hawley, 1948, maps and report.

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q Quartz phenocrysts
 Bi Biotite
 Chl Chlorite
 Carb Carbonate
 Dal Dalmatianite
 Gar Garnet
 Ser Sericite

MINERALIZATION

py	Pyrite	sph	Sphalerite
po	Pyrrhotite	mag	Magnetite
cp	Chalcopyrite	hem	Hematite

SYMBOLS

- Rock pits and trenches
- Significant sulphide showing
- Bedding attitude, attitude, direction of tops indicated
- Foliation attitude
- Jointing attitude
- Facing direction, from pillowed lava
- Fault or major shear zone
- Local shearing
- Lineament
- D D H, vertical, inclined with angle indicated
- Survey post
- Area of sulphide stain and gossan
- Outcrop area
- Geological contact observed, interpreted
- Motor access road
- Road closed to motor vehicles, or for winter use only
- Grown-over trail or road
- Low, swampy area
- Old concrete foundation
- Chemical analysis and sample number as in text
- Section line

10 of 10

END

1 7 1 2 8 1 1

FIN