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Meetings

Annual Meeting of the Atlantic Universities Geological Conference held at Saint Francis Xavier University, Antigonish, Nova Scotia.

The following abstracts and papers were submitted to the conference and represent contributions from the student body of the participating universities.

The Geology of North-Eastern New Brunswick with Reference to the Rocks of Red Brook by Robert Stewart, Gestner Geological Society, Mount Allison University, Sackville, New Brunswick:

For the past two summers I have worked with the New Brunswick Department of Natural Resources on a geological crew doing quarter-mile mapping of north-eastern New Brunswick. At the end of this past summer I remapped and sampled a section of Red Brook for use in my thesis. Tonight I will be talking on the general geology of this northern corner of New Brunswick with specific interest in the Red Brook area.

This section of New Brunswick is composed of Silurian and Devonian sedimentary and volcanic rocks which were intruded by Devonian granites. These rocks lie unconformably on deformed Ordovician rocks which outcrop south of the Rocky Brook-Millstream fault. These rocks are of the Tetagouche group which are severely deformed, mildly metamorphosed shales, greywackes, volcanics and chert intruded by granodiorite.

The sediments were deformed by a series of events during the late Ordovician which are comparable and contemporaneous to the Taconic orogeny that was deforming sediments in Northern Gaspe. The land mass created by the Taconic orogeny in Gaspe has been called the Quebec Geanticline, and the land mass that was created in the New Brunswick area, the Miramichi Geanticline. These two land masses bounded and provided limy sediments for the Gaspe Trough, which is 20-40 kilometres wide at present and probably was a seaway several times wider in the Paleozoic. This was the geographical setting for the environment in which the Silurian and Devonian rocks were formed. The seaway was fairly shallow and limy with abundant fauna in some localities which contain good guide fossils for the various formations.

The Silurian rocks are called the Chaleur Group. In the lower part of the sequence are sedimentary rocks overlain by large amounts of felsic and mafic volcanics. Over these rocks there is a red volcanic boulder conglomerate with intercalated finer sediments. The Upper Silurian sediments are absent in many places possibly due to erosion, non-deposition or volcanics may be present.

The Devonian rocks continue this sequence of interbedded volcanics and sediments. Local unconformities have been noted throughout the Silurian and Devonian and these are possibly due to coarse sediments deposited on semi-eroded volcanic islands. These units remained relatively undisturbed throughout the Silurian and Lower Devonian until the principal orogenic deformation, the Acadian Orogeny.

The presence of sandstone and conglomerate units suggest several episodes of uplift and erosion during the Devonian. The Acadian Orogeny in this area was possibly active in three pulses; Early, Middle and Upper Devonian or was continuous throughout and the coarse sediments were deposited in isolated basins which may have been preserved and exposed. The Acadian Orogeny produced the Chaleur Bay Synclinorium which trends from Mount Carleton at 035° and at Chaleur Bay, 060° or even more easterly. In New Brunswick the deformation produced regular northeasterly trending fold axes with an average wave length of two to three miles.

There is a large open syncline in the north (the Restigouche Syncline) which has in its core Silurian rocks, overlain uncomformably in some places by more than a kilometre of Devonian sandstone and conglomerate. The pebbles of the conglomerate are Ordovician and Silurian in age, so we can deduce that deformation, uplift and erosion had begun by Middle Devonian.

Southeast of the Restigouche Syncline is a more tightly folded and faulted synclinorial belt which extends from Chaleur Bay to Maine on a northeasterly axis. The rocks in northern New Brunswick are calcareous but become less limy towards the southwest, and in Maine they are shales and greywackes. The volcanics interbedded in the sediments also tend to pinch out about 100 miles from Chaleur Bay.

The base of the Chaleur Bay Synclinorium is exposed only at Port Daniel in southeastern Gaspe where it unconformably overlies Taconic-deformed Ordovician sediments. The synclinorium is terminated on the south by the Tetagouche Group which comprises the Ordovician sediments deformed by the Taconic Orogeny. These appear to have been overthrust onto the younger strata along the Rocky Brook-Millstream fault.

The Devonian granitic bodies associated with the Acadian Orogeny in the northern corner have been dated at 380-395 million years. They are mostly granodiorite to quartz monzonite in composition. Martin has placed them in an axial belt which runs from Chaleur to Maine. He states that they are subsolvus, of mesozonal emplacement and relatively rich in volatiles having had a high water pressure. As a result of these conditions one would expect that the two feldspars would form as discrete grains and not in a perthitic intergrowth.

In relation to this broad summary of Northern New Brunswick, how does my thesis area, Red Brook fit in? As we see here, Red Brook is located near the Rocky Brook-Millstream Break. Red Brook is in a wide U-shapes valley with fairly continuous small outcrops and talus slopes. The brook has a gentle gradient and over four miles of brook mapped I descended only 400 feet from 1050' to 650' in elevation. I collected 162 specimens from 121 outcrops. The section runs at about 120^{o} through a volcanic section which is on the northern limb of a northeasterly trending syncline. All the strata dip southward at an angle of about 20^{o}.

The age of all the rocks at Red Brook is Silurian. At the northern boundary of the study area is a siltstone outcrop containing a variety of phyla but the most important is the Middle Silurian brachiopod Stricklandia gaspiensis. This unit underlies the whole thesis area and all the volcanics are Middle Silurian and younger. About one mile beyond the southernmost outcrop there is another sedimentary unit containing brachiopods, corals, crinoids, and trilobites and this has been determined as Lower Devonian in age. This unit overlies the volcanics and therefore from these limits the Red Brook Volcanics are Middle Silurian to Lower Devonian.

The volcanics are basalt, feldspar porphyry, rhyolite, dacite, trachyte in the form of flows and pyroclastics. There is an abundance of basalts, and a notable lack of rhyolite in the northern part of the brook. This corresponds to the Bryant Point Formation, a 1000' unit of the Lower to Middle Silurian. The southern part has an abundance of rhyolite which correlates with the Benjamin Formation. There is a notable lack of the New Mills Formation, a red volcanic boulder conglomerate and sediment that is mapped between these two formations to the northeast.

Potter interpreted a fault between the two units but it is an assumed structure and I found no evidence of a fault in this area in my study. The New Mills Formation is absent in the whole area, and probably the formation represents isolated bains. The Red Brook area is between these basins.

The Pennsylvanian Bonaventure Formation is also absent here. The Bonaventure is restricted to theshore line of Chaleur Bay. The overburden on the Red Brook area is Pleistocene unconsolidated till.

In summary, then, the Red Brook section shows a sequence of sedimentary and volcanic rocks of four formations which comprise most of the Silurian strata of northeastern New Brunswick. They were formed in a shallow sea between two Taconian derived landmasses, nearer the Miramichi Geanticline in a eugeosyncline with mafic and felsic volcanic activity. The strata were then deformed by the Acadian Orogeny and intruded by granites, and have since then been eroding away until present with no periods of deposition and consolidation.

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Background and Geology of the Canada Tungsten Mine, Tungsten, N.W.T. by Dianne McClintock, Bailey Geological Society, University of New Brunswick, Fredericton, New Brunswick:

The Canada Tungsten mine is located in the Logan Mountains, a part of the Selwyn Range which in turn forms part of the Cordillera. It is Canada's only tungsten producer and was an open pit operation until 1973, when the entire operation went underground and the open pit ceased operations.

The open pit orebody is located in a thick skarn formation at the base of a limestone unit, on the upper limb of an anticline. The underground orebody is located in the same unit as the open pit except in the lower limb of the anticline.

The deposits are pyrometasomatic, scheelite-bearing skarn type deposits and occur in a limestone of Cambrian age. The underground orebody differs mineralogically from the open pit. The underground is a skarn which consists of pyrrhotite and phlogopite with disseminated scheelite and minor chalcopyrite. None of the silicate skarn minerals, diopside and garnet, are common. In the skarn, the scheelite mineralization is the oldest.

A fault zone, an anticline and syncline, and a chert-limestone contact are the main structural contols on the size and shape of the orebody.

The exploration project for tungsten is based on theories concerning rock association: that is, the rock type associated with skarn, with skarn formation, with scheelite (that is, limestone) and the associated mineral assemblages.

Geochemical and geophysical methods are employed in searching out skarn outcrop. These methods usually prove successful in finding an outcrop if present.

The factors governing the development of an outcrop are:

1. size of outcrop
2. grade of ore
3. accessability of the area

With much luck and good geological techniques, an outcrop of mineable grade is some times discovered. Such was the case with the Canada Tungsten Mine.

Analysis of Geological Materials by Energy Dispersive X-Ray Fluorescence by W. Keenan, W.A. Bell Geology Club, Saint Mary's University, Halifax, Nova Scotia

Geology, like many other rapidly evolving fields, must look to other disciplines for help in solving many of its problems. One such discipline which has proven to be valuable in the understanding of geological puzzles, is that of geochemistry. For one of the greatest needs of individuals involved in geological research is for qualitative and quantitative chemical information. On the basis of these data, many relationships can be perceived and clues to the genesis of rocks and minerals can be obtained.

One of the very effective analytical tools available for these ends is energy-dispersive x-ray fluorescence. Although this technique is quite a recent development, it is nevertheless well established in both industry and research as a reliable method of non-destructive elemental analysis.

Perhaps the best way to describe the phenomenon of x-ray fluorescence is by means of a basic model of the atom. The orbiting electrons of an atom are grouped in shells in order of increasing distance from the nucleus, the innermost shell being designated as the K shell which is surrounded by the L, M and N shells etc. Subjecting the atom to radiation may cause an electron to be ejected from the atom, which results in a vacancy in one of the electronic shells. This vacancy is then refilled by an electron from a shell more distant from the nucleus which readily moves into the unfilled shell. In order to conserve energy, the excess of energy will be emitted as an x-ray whose energy is equal to the energy gap between the two shells involved. The energy gap between the electronic shells, that is to say, the energy of the emitted x-ray, is characteristic of the element. Thus, the determination of the amount of energy of the individual x-rays emitted from a sample provides an indication of the elements present in the sample, while the determination of the number of characteristic x-rays emitted from a particular element provides an indication of the amount of that element which is present in the sample. These two types of determinations represent qualitative and quantitative analyses, respectively.

The emissions that are the most important and most widely used for analytical purposes are the K-alpha x-rays. These occur when one of the innermost, or K shell, electronics is ejected from an atom by an inelastic collision with an exciting x-ray, and the vacant location is then occupied by an electron jumping from the L shell to the K shell. K-beta x-rays, which have slightly higher energies than K-alpha x-rays result when an electron jumps from the M shell to the K shell. The abundance of the K-beta transistions is roughly one sixth of the K-alpha transitions. This usually makes them less desirable for detection purposes than the K-alpha x-rays. The K-beta radiation will sometimes be preferred. However, this usually occurs when emissions from another element in a sample have energy values close enough to those of the K-alpha x-rays to interfere with their determination. For elements with high atomic number, additional types of discrete x-ray energies can be measured. These are the L x-rays, which result when the L shell is filled by electrons from the more distant shells. These may be preferred when conditions of interference are encountered, as they are of lower energy than the K x-rays and therefore are not interfered with by the same energy as the K x-rays.

The requirement of the incident radiation, if it is to remove an electron from an atom, is that it must have an energy greater than that which binds the electron in its orbit. This energy defines what is known as an absorption edge. Each shell has its own absorption edge, with that of the K shell having the highest value. A photon whose energy is just below that of the K shell absorption edge will tend to pass directly through the atom. As the energy of the excitation x-rays is decreased, this transparent tendency of the atom continues until the absorption edge of the L shell is approached, and so on. Thus, although the energies of transition of an electron from one shell to another are less than those of the absorption edges, no transitions take place as all the outer shells are filled when the exciting x-ray arrives. Therefore, the primary x-ray must have sufficient energy to completely remove one of the inner electrons in order to emit fluorescent x-radiation.

In the energy-dispersive type of x-ray fluorescence with which we are dealing, the incident radiation is produced by sources composed or radioactive isotopes, The particular source which is to be used is determined by the characteristic x-ray energy of the elements to be analysed.

Once the sample has been excited, the emitted x-rays must go through several stages before they produce any output. First the x-rays pass through a detector composed of a lithium-drifted silicon disc, where each x-ray absorbed will produce a track of electrons. The number of these electrons collected at the terminals is proportional to the energy of the x-ray. A high voltage bias applied across the detector feeds these electrons into a field-effect transistor preamplifier which amplifies the stream of electrons and converts them into a series of electronic pulses. The magnitude of each pulse is dependent on the number of electrons collected at a given time, and again proportional to the x-ray energy. These pulses are then reamplified and sent on to a multi-purpose analyser. Upon reaching the analyser, each pulse charges a capacitor. The amount of time necessary for the capacitor to discharge depends on the magnitude of the charge which in turn depends on the magnitude of the pulse. This characteristic time of discharge then is easily measured and may serve as a computer address and also trigger the addition of one count in this address. Therefore a count is maintained of the number of pulses producing a given time of discharge on a capacitor, all of which relates back to the x-ray energies emitted by the sample. The computer than interprets this time in terms of x-ray energy and can produce a graphic display of energy vs. number of counts, or a numeric readout of number of counts per energy range, or both.

One problem which arises in x-ray analysis is the scatter of x-rays. In all methods of excitation there is backscatter from the source itself which means that the detector assembly absorbs some of the incident radiation.

If these collisions are elastic, that is, if there is no loss of kinetic energy by the colliding electrons, it is known as coherent or Raleigh scattering. If the collisions are inelastic, and result in both the release of an electron from the amterial and a scattered photon, it is known as incoherent or Comptom scattering. This causes both the production and detection of energies with values inconsistent with those of the element of interest. Too much of this background and secondary scattering then, would seemingly result in a loss of sensitivity of the equipment. However, a convenient aspect of this occurence is that the ratio of the fluorescent peakcounts of interest to the Compton backscatter peak is fairly constant, and depends on the sample composition. This permits the use of the backscatter peak as an internal standard. Therefore, by taking the ratio of peakcounts for a standard sample with a known elemental concentration, one can easily calculate the constant by which this ratio for an unknown sample must be multiplied in order to obtain a concentration value for that unknown. This is a simple procedure and can be used in all but some special cases. In addition to this, as the charged particles approach the atoms of the sample they undergo a deceleration due to the electrostatic fields of the sample atoms. This results in a consequent release in energy known as Bremsstrahlung or braking radiation. This radiation is the source of the background detected by the machine. Two additional types of backscatter occur as a result of the emitted x-rays colliding with the atoms of the silicon detector assembly itself.

As is the case for virtually any instrument possessing any degree of sensitivity, the x-ray fluorescence analyser must be calibrated before use in order to give its output any significance. Our system is calibrated by placing a mono-elemental sample, such as copper or silver above the detector and choosing the appropriate radioactive source to excite it. The sample element is known to emit x-rays within a well-defined range of kilo electron volts, for instance 30 to 24 Kev for copper using an Iodine 125 source. These values are listed for each element in a convenient set of tables supplied by the manufacturer. The machine is then programmed to detect a portion of this radiation in each of its four regions.

The analyser can now be programmed to detect radiation in up to eight distinct regions if both programs are used. Generally, however, only one is employed for purposes of convenience. This enables one to measure a different element in three regions, with the fourth normally reserved for measuring the backscatter. When the three elements desired, have been chosen, the upper and lower limits of their characteristic x-ray energies, along with the characteristic backscatter limits for the appropriate source, are each programmed into the machine to be detected in a separate region. If the iron 55 source is to be used, for example, the elements that can be sought must be within the range of silicon to chromium on the periodic table. A similar range of elements is prescribed for each source.

The machine can now be set to measure the amounts of the elements and backscatter for either a selected period of time or a chosen number of counts. Normally the former option is used, with the time being set so as to accumulate a large enough number of counts to ensure the statistical probability of high analysis accuracies. The length of time necessary is determined by the concentration of the elements in the sample. That is to say that a major element will emit considerably more x-rays than a minor element, and thus take less time to produce a given number of counts.

All of the samples analysed on this system have been prepared by crushing them to less than 200 mesh. This produces a fairly homogenous sample with the individual grains being mono-mineralic and yielding good results. Each sample is usually analysed a total of five times to ensure statistical accuracy of results. The samples are measured along with several International Standards. The United States Geological Survey samples are used as standards for calibration of curves and are also run as unknowns to check the determinations. The values obtained from the analyses of these standards are used to plot calibration curves for individual elements, from which the unknown elemental concentrations in the samples are calculated.

The only aspect of energy-dispersive x-ray fluorescence which remains to be discussed is that of its practicality. Relative to alternate methods of instrumental analysis. As far as cost is concerned, it is not much more expensive than the best available atomic absorption units, and far less expensive than dispersive x-ray systems. The range of detectable elements afforded by this system is as wide as that of all but the best wavelength-dispersive models. The energy-dispersive system is also equipped with a helium purge for detection of the lighter elements such as silicon aluminium. The detection limits of this x-ray machine are comparable to those of dispersive machines, although some what higher for certain elements than with A.A. methods. Elements close to the radiating sources on the periodic table yield excellent results. However, the energy-dispersive machine, I might add, is able to analyse not only powder, but solid and liquid samples as well. As opposed to the dispersive systems, it is also much more rugged and compact and replaces an essentially mechanical method with an electronic one.

In conclusion, then, I would simply like to reaffirm my contention that the energy-dispersive method of x-ray fluorescence can be of considerable value to anyone involved in geological research to whom it is available.

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The Relationship between the Cape Brule Porphyry and the Cape St. John volcanics, in the eastern Burlington Peninsula, Newfoundland by Campbell Delong, Alexander Murray Club, Memorial University of Newfoundland, St. John's, Newfoundland:

The Cape Brule Porphyry is an acidic intrusion located on the eastern Burlington Peninsula, northern Newfoundland. The relationship of the intrusion to the surrounding rocks is unclear, although field evidence suggests that it is a high level pluton which both intrudes and feeds its own volcanic pile, the Cape St. John Volcanics. Further field evidence suggests that the age of this igneous association is Silurian, in contrast to previous interpretations that it was probably considerably older.

Numberous inclusions are found distributed throughout the prophyry which suggest that it was intruded through ophiolitic rocks. It is therefore suggested that the sequence represents the culminating stages of the development of the Lower Palaeozoic island are terrain of Central Newfoundland.

The field work was carried out during employment as an assistant with the Newfoundland Department of Mines which is engaged in a program to remap much of the northern Burlington Peninsula.

Diagenesis and Sulphide Mineralization at Gays River by John MacLeod, Dalhousie University, Halifax, Nova Scotia:

The Gays River sulphide deposit lies within carbonates of the so-called "B zone" of the Windsor group. Four basic carbonate rock types consist of palmicrite, biopelmicrite, algalbound sediments and coral bearing sediments of the aforementioned. Each type can be considered indicative of certain sedimentary environments.

Early diagenesis include the effect of boring algae and dolomitization. Dolomitization probably occurred as a result of evaporitic reflux of waters with high Mg/Ca ratios.

Relatively early in the diagenetic history, after dolomitization, sulphide minerals were introduced with the generalized paragenetic sequence of Fs, Zn, Fb, Cu. Flourite entered the system sometime after sphalerite deposition.

Pore space utilized was caused chiefly by dolomitization, preservation of fossil voids, and fenestral fabrics or birdseye structures in the algal tustular mar (P-mat).

Two types of mechanisms causing a secondary concentration of the sulphides occur: Mechanical concentration due to carbonate leaching by (1) ground water and (2) pressure-solution.

A late diagenetic effect, which is indicative of subareal exposure, is the dedolomitization of the dolomite. Its existance is shown through the use of cathodoluminesence.

Geology of the Mts. McGerrigle-Madeleine River Area, Gaspe, Quebec by Tony Dal Bello, Faribault Geology Club, St. Francis Xavier University, Antigonish, Nova Scotia:

Introduction

During the summer of 1974, while in the employ of Noranda Explorations, I did detailed geologic mapping in the Mts. McGerrigle batholith - Madeleine River area, Gaspe, Quebec. The most important structural feature of the peninsula is the Gaspe-Connecticut Valley synclinorium. It is made up of three lithologically distinct east-west trending belts, the Northern, the Central and the Southern belt.

The Mts. McGerrigle Batholith area is located in the southern portion of the Ordovician-aged Northern belt and in the norther portion of the Siluro-Devonian aged Central belt. A closer look at the area reveals the granitic balholith surrounded by Quebec Group rock. Shickshock Group rocks are found on the southwest corner of the batholith. Silurian and Devonian formations are found south of the intrusive.

The objects of this paper are to describe the geology of the area and to attempt an explanation for the origin and distribution of sulphide mineralization about the batholith.

Formations

The Ordovician-aged Northern belt is made up of the Quebec and Shickshock Groups. The Shickshock comprises phyllites, sericite schists and meta-andesites. The sedimentary, basic volcanic rocks of the Quebec Group have been altered by contact metamorphism, caused by the baltholith, to calc-silicate hornfels, pelitic hornfels, skarn slates and meta basalt.

The Ordovician and Silurian-aged units are separated by a regional north-east trending thrust fault, the Silurian being thrust over the Ordovician. The Silurian is comprised of three formations: the Val Brilliant, the Sayabec and the St. Leon.

The Val Brilliant is a white quartzite formation, 300 feet thick. The well sorted nature of the rock suggests a stable marine environment of deposition. The Sayabec is a grey, fossiliferous limestone formation, 600 feet thick. It conformably overlies the Val Brilliant. The St. Leon is commonly dividied into an upper and lower section. The lower section is made up of tuffs intervedded with limestone conglomerates. It is approximately 700 feet thick. The upper section is made up of calcareous siltstone and is 1000 feet thick. The bedding of all three formations trends to the northeast and dips gently to the southeast. The rock assemblages are typical of a stable marine environment of deposition.

Conformably overlying the Silurian are Devonian formations, made up of argillaceous and siliceous limestones topped by conglomerates and sandstones of a terrestrial environment of deposition. Like the Silurian, the Devonian is made up of three formations: the Cap Bon Ami, the Grande Greve and the York River. The Cap Bon Ami formation has a thickness of around 1000 feet. The rock type is a massive, argillaceous and carboraceous limestone. The Grande Greve formation has a thickness of 2000 feet and is made up of argillaceous and siliceous limestones. The formation conformably overlies the Cap Bon Ami. The York River formation conformably overlies the Grande Greve. It is a quartz feldspathic wacke formation.

Mts. McGerrigle Batholith

The Mts. McGerrigle Batholith is approximately twelve miles in length by six miles in width. It is named after H.W. McGerrigle, who did a good deal of geological work in the Gaspe for the Quebec Provincial Government. It was formally known as the tabletop Mountain. The highest point is Mount Jaques Cartier which is 4160 feet above sea level.

The rock types of the batholith range from granite to syenite to felsite to diorite. The granite is typically a medium-grained holocrystalline rock composed of quartz and k-feldspar with minor hornblende or biotite. The syenite has much the same characteristics as the granite. Felsite veins are quite common. The rock is fine grained, red to pink in color and frequently contains quartz phenocrysts. The diorite is dark gray and is believed to be xenoliths of the original roof rock, which were not totally assimilated by the granitic magma.

The method of emplacement of the batholith undoubtedly was by forceful injection. There are a number of facts supporting this theory:

(1) the contact between the batholith and the country rock is a sharp one;

(2) veins of granitic composition coming from the batholith cut into the country rock. This would not be the case if the batholith was emplaced by, say, metasomatic replacement;

(3) the bedding in the country rock abutting against the batholith has been dragged and intensely folded, indicating forceful penetration of the batholith; and

(4) the aureole surrounding the batholith is fairly uniform in width indicating a central location for the metamorphic agent which in this case was predominantly heat.

The aureole, itself, is approximately 1.5 miles in width. It is divided into an inner and outer aureole on the basis of extent of metamorphism. The outer aureole is marked by the albite-epidote hornfels facies and is 3500 feet in width. The inner aureole is marked by the hornblende-hornfels facies and is 4000 feet wide. The thermal gradient produced by the intruding granitic magma not only produced the aureole but also caused the conversion of primary pyrite in the country rock to pyrrhotite with the release of free sulfur. This point will be discussed further in the economic geology section.

The longer dimension of the batholith is in the north-south fractures, these fractures being related to thrusting along the thrust fault known as Logan's Line. Logan's Line is Ordovician in age and runs up the St. Lawrence, following the coast line of the Gaspe Peninsula. The fault is curved which means there must have been expansion along the front. This expansion would cause fractures to form roughly perpendicular to the fault line. In the McGerrigle batholith area the fractures would be in the north-south direction. The batholith is Devonian in age, having a K/Ar age of 353 million years, so the fractures must not have tapped a magma source initially. With the coming of the Acadian Orogeny, Logan's Line was reactivated and undoubtedly the fractures were also reactivated. Following the orogeny release tension deformation opens the fractures allowing the magma to flow upwards to form the batholith.

Structural Geology

Two tectonic events have primarily shaped the structure of the area. The Ordovician-aged Northern belt was affected by the Taconian and Acadian orogenies, and the Silurian-Devonian Central belt was affected only by the Acadian.

The Taconian orogeny is characterized by S_1 cleavage. This cleavage is found parallel to bedding in most cases or intersecting it at a very small angle, suggesting that the F_1 folds were isoclinal in nature. The Acadian orogeny produced S_2 cleavage and F_2 folds. The cleavage is found frequently cutting S_1 cleavage and bedding at a high angle. In most cases observed it was approximately 45 degrees. The northeasterly trending F_2 folds have totally overriden the F_1. The F_2 folds range from open to isoclinal in nature.

The structure of the Silurian-Devonian rocks of the Central belt is simple in contrast to the highly deformed Northern belt. It was effected by the Acadian orogeny, as stated earlier, producing F_2 folds which for the most part, in this belt, are broad upright and shallow plunging folds.

Economic Geology

Three major mineral occurrences have been found in the Mts. McGerrigle area, only two of which I feel are directly related to the batholith. These are the Madeleine Mines and Candego Mines. The other, the Pekan Brook, disseminated copper-molybdenium deposit, is found in Silurian-aged rocks south of the batholith. The copper occurs in skarn produced by the intrusion of an acidic porphyry into the impure limestone of the area. The molybdenium is found in fractures in the porphyry.

Madeleine Mines, situated on the northwest flank of the batholith, is a fracture-filled type of ore deposit. The ore (bornite, chalcopyrite) is found in five, steeply plunging, chimney-shaped ore bodies. The host rock is a 300-foot thick, metamorphosed silty shale unit. Producation is approximately 10,000 tons of copper metal annually. Reserve tonnage at the present time is 4.5 million tons at 1.17% copper.

Candego Mines is situated in township some four miles west of the batholith. It was a lead zinc deposit in operation between 1948 and 1952. The silver-bearing galena and sphalerite were found in quartz veins following strike-slip structures in folded shales, sandstones and slates.

By plotting Madeleine and Candego mines and all other copper and lead showings related to the batholith, one can develop a mineral zonation pattern. As I stated earlier the thermal gradient established by the intruding granitic body caused the conversion of pyrite (FeS_2) to pyrrhotite ($Fe_{1-x}S$) with the subsequent release of sulphur. Copper and lead atoms formed molecules with the free sulphur. The origin of the copper and lead may either have been from hydrothermal solutions or from mobilization of copper and lead in the surrounding country rock. The true origin is most likely a mixture of the two. Copper sulfide, being more stable at high temperature, precipated out first, close to the batholith. The lead sulphide having a lower vaporization temperature than the copper sulfide must move away from the batholith, where the temperature is less, to precipate out as galena, and thus zonation results; chalcopyrite and bornite close to the granite with galena further away.

From what I observed, the placement of copper mineralization close to the batholith occurred in fractures. Skarn found in the aureole was barren. For fractures to develop there must be present reasonably brittle rocks. From what I saw, the argillites and pelitic hornfels best fit this category.

By the end of the summer, after covering the entire eastern flank aureole area of the batholith, we found no deposits except for a few minor showings. This brings up the question as to whether Madeleine Mines is the only copper deposit about the batholith.

Granitic intrusions, through the process of differentiation, tend to become zoned. The first rock to crystallize out of the melt is rich in anorthite and mafic minerals such as hornblende. The last rocks to crystallize out are of a much more acidic nature. As crystallization occurs volatiles (mineralized solutions) become concentrated toward the central area of the consolidating batholith in the still molten rock. No copper mineralization has ever been found in the interior of the McGerrigle batholith, so the volatiles associated with it must have escaped. If, as may be the case with the McGerrigle batholith, the zonation may not have been uniform but is thinner at a point and wider at others. With a shorter route made available most of the volatiles would escape via this route, by way of fractures, which have a higher probability of forming quicker in the thinner area than in the wider areas. The thin area would consolidate faster. This route led to the Madeleine Mines area. This idea is supported by the presence of Candego Mines in the same area, just six miles northwest of Madeleine. Returning to the mineral zonation scheme, if a copper deposit is precipating out, one would expect a lead deposit to precipate out in the immediate area. This is the case in Candego Mines.

Fossils as a Key to the Depositional Setting of The Herbert River Limestone by Robert J. Ryan, Acadia University, Wolfville, Nova Scotia:

The Herbert River Limestone lies within the "C" subzone of the Windsor Group and was defined by Moore (1967) as being that part of section 5 which Bell described as units g and h, of the "C" subzone. Several investigations of the Herbert River Limestone sections described by various workers were examined and their fossil and lithological relationships were established. The investigations conducted consisted of collecting oriented samples of both lithologic units and any observed fossils present. From this basic field work a general fossil sequence was established within the Herbert River Limestone and correlated from the Windsor-Brooklyn area of Nova Scotia to as far as Ile Coffin, Magdaleine Islands.

The basic sequence of fossils starting at the stratigraphic bottom is

(1) Stromatolites

(2) Ostrocods

(3) a primarily brachiopod biofacies

(4) the biofacies of maximum transgression represented by a unit made up of singular corals (Dibunophyllum lambii and Koninckophyllum avonensis), bryozoans (including Anisotrypa), clams and a few brachiopods.

From this point there is a reversal of the above sequence.

(5) a Brachiopod unit which had crinoidal debris present,

(6) An Ostrocod biofacies and finally

(7) planar stromatolites at the top of the sequence.

By examination of the paleoecology of the different forms present in the various biofacies it is possible to extrapolate the environment of deposition of these fossils, given that they are indicative of these biofacies.

Because of the nature of the ecological niche and the mode of growth of the fossil forms it is possible to approximate the bathymetric range of deposition and, also, the amount of energy reflected by the biofacies and thus its depositional environment.

It is obvious on examination of the basic sequence of fossil forms that the Herbert River Limestone is a reflection of a transgressive-regressive cycle, starting in the supratidal zone (represented by the planar stromatolites) transgressing to the sublittoral zone below wave base (represented by the singular corals) and regressing back to the stromatolites of the supratidal zone at the top of the sequence.

In conclusion it is evident that the fauna within the Herbert River Limestone does reflect the environmental setting.

Waterloo '75: Joint Meeting of the Geological Association of Canada, the Mineralogical Association of Canada, and the Geological Society of America North-Central Section, University of Waterloo, Waterloo, Ontario, May 15-17, 1975.

The Geological Association of Canada, the Mineralogical Association of Canada and the North-Central Section of the Geological Society of America will jointly hold their annual meeting at the University of Waterloo, Waterloo, Ontario on Thursday, Friday and Saturday, May 15-17th, 1975. The meeting is being held in conjunction with the N.C. Section of the Paleontological Society, the Pander Society, the E.C. Section of the National Association of Geology teachers and Divisions of the Geological Association of Canada. The meeting is sponsored by the Department of Earth Sciences, University of Waterloo.

Twelve field trips are planned.

1. Precambrian Grenville Granitic Rocks. W. Chesworth and D.M. Shaw. Subvolcanic to catazonal igneous rocks of the Madoc-North Bay area. Contacts and metamorphic grades. Includes classic area of Adams and Barlow.

2. Grenville Gneisses in the Madawaska Highlands (eastern Ontario). E.C. Appleyard and G.M. Stott. Lithostratigraphic and structural relationships of the Grenville supergroup rocks. Examination of migmatites and stratigraphically controlled igneous and metasomatic nepheline and scapolite rocks.

3. Precambrian Economic Geology. P.T. George. Volcanic stratigraphy of the Timmins-Kirkland Lake area. Visits to McIntyre, Texasgulf, Langmuir mines with local geologists. Assemble at Timmins with termination at Waterloo.

4. Ordovician and Silurian Stratigraphy and Conodont Biostratigraphy of Southern Ontario. C.R. Barnes, C.G. Winder, and P. Telford. Ordovician and Silurian carbonates and clastics with opportunity to collect conodont samples.

5. Devonian Stratigraphy and Conodont Biostratigraphy of Southwestern Ontario. C.G. Winder, P. Telford, and T.T. Uyeno. All major units of Devonian carbonate and fine clastic sequence with opportunity to collect conodonts. Trip will move up the section from Silurian contact to Kettle Point Formation.

6. Quaternary Stratigraphy of the Toronto Area. P.F. Karrow and A.V. Morgan. Interglacial and interstadial stratigraphy of Toronto area. Classic exposures of Don Brickyard and Scarborough Bluffs. Quaternary fossils.

7. Quaternary Geology, Waterloo to Lake Huron. W.R. Cowan, P.F. Karrow, A.V. Morgan, and A.J. Cooper. Glacial geology and geomorphology of the Huron, Erie, and Ontario ice lobes and the interlobate area. Middle Wisconsinan interstadial sites; till character and stratigraphy.

8. Industrial Minerals of the Paris-Hamilton District, Ontario. M. Vos. Sand and gravel operations, gypsum mine, Devonian quarry and cement plant, Silurian dolomite quarries, Ordovician shale brick plant.

9. Engineering Geology, Niagara Peninsula. P. Morris and O.L. White. Lake Ontario shoreline erosion, St. Catharine expressway construction, Niagara Falls pumped storage and hydro-generation, American Falls reconstruction, Welland-Town Line tunnel, Thorold tunnel, and flight locks.

10. Environmental Geology, Kitchener-Guelph Area. O.L. White and P. Morris. Urban geotechnical data collection, landfill sites, Guelph water supply, gravel pit rehabilitation, housing sites.

11. Geolimnology, Lake Ontario. A.L.W. Kemp and D. E. Lawson. Bottom sampling and sounding techniques, water chemistry, shipboard facilities, open lake and harbour sites.

12. Mineralogy and Economic Geology of the Cobalt Silver Deposits. S.D. Scott and J.L. Jambor. General geology of Cobalt area; underground visit to silver mine; open pit and mill at Sherman iron mine. Assemble at North Bay with termination at Waterloo.

A special exhibit commemorating the centennial of the death of Sir William Logan, founder and first director of the Geological Survey of Canada, will be organized by C.G. Winder (University of Western Ontario).

Additional information, requests, or suggestions should be directed to the chairmen.

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Exploration Update '75: A Joint Convention of the Canadian Societies of Petroleum Geologists and Exploration Geophysicists (Calgary, Alberta), May 20-23, 1975.

The Canadian Societies of Petroleum Geologists and Exploration Geophysicists are co-hosting their annual convention in Calgary, Alberta, May 20-23, 1975. "Exploration Update '75" will be featuring recent advances in exploration technology and exploration concepts.

Following the technical sessions, a joint geological - geophysical field excursion will lead the participants westward to Alberta's foothills and front ranges where practical exploration approaches will be investigated.

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Benthonics 75: First International Sumposium on Benthonic Foraminifera, Dalhousie University, Halifax, Nova Scotia, Canada, August 25-28, 1975.

During the course of the 3rd Planktonic Conference held in Kiel in 1974, a number of earth scientists interested in benthonic Foraminifera assembled on two occasions to discuss the need for a symposium devoted to these organisms. The Canadian delegation indicated a willingness to organize such a symposium pending favourable response from the necessary support agencies. The Co-ordinating Committee is pleased to announce that the idea was received enthusiastically by those agencies contacted, and planning for the First International Symposium on Benthonic Foraminifera is now well under way. Discussions in Kiel focused in part on some of the major unresolved problems in this area of research. The objectives of this Symposium are thus designed to:

(1) summarize the "state of the art" in the broad areas of taxonomy, ecology, paleoecology and biostratigraphy,

(2) examine the broad application of new techniques and procedures and attempt to reach a concensus on standardized approaches,

(3) improve a one-to-one communication between researchers throughout the world, and

(4) identify new areas of research.

First circular responses, which were mailed in December, 1974, indicate a strong interest in ecology and methodology. We hope that the biostratigraphic and paleoecological factions will also make a strong contribution to the final Technical Program.

Accepted abstracts will be published in a single volume that will be made available to all participants during the registration.

During the Symposium, discussions and workshop proceedings will be recorded; and an attempt will be made to organize relevant information into a second volume that would be made available to Benthonics '75 registrants at cost.

There will be no refunds for particpants who are not able to attend. However, Symposium documents will be forwarded to individuals by the Co-ordinating Committee.

Technical Committees:

Biostratigraphy: F.M. Gradstein
Ecology: G.A. Bartlett
Methods & Techniques: C.T. Schafer
Paleoecology: P. Ascoli
Systematics: G. Vilks
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