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GEOLOGY OF THE ASBESTOS OPHIOLITIC COMPLEX, SOUTHERN QUEBEC

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GEOLOGY OF THE ASBESTOS OPHIOLITIC COMPLEX, SOUTHERN QUEBEC

by

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INTRODUCTION

A special geological study of the Asbestos ophiolitic complex was carried out in 1971 and 1972 for the purpose of outlining the distribution of its main lithologic units, of establishing their stratigraphic and tectonic relations with adjoining units and, finally, of assessing its economic mineral potential, especially for asbestos, chromite, nickel and copper.

The easy access throughout, the good outcrop distribution, the numerous drill holes and the aeromagnetic and ground magnetic maps enabled the writer to outline the various lithologic units of this igneous complex and of the adjacent formations with a reasonable degree of accuracy, taking into account the ¼ mile to the inch (1/15,840) scale at which the field study was carried out.

Even though of limited thickness, this ophiolitic complex shows a considerable extension along its NE-SW strike, having been traced continuously from Petit Mont Ham, to the northeast, to Bowker lake, to the southwest, a distance of over 35 miles.

GEOLOGY AND ORIGIN

The Asbestos ophiolitic complex rests southeast of the older metasedimentary rocks of the Sutton-Bennett tectonic belt and northwest of the contemporaneous or slightly younger, aluminous and predominantly wildflysch-type metasedimentary rocks of the Saint Daniel formation.

The Asbestos ophiolitic complex is composed of brecciated and pillowed mafic volcanic rocks of spilitic affinity; of gabbroic, doleritic and dioritic rocks; of pyroxenites (mostly clinopyroxenite and minor websterite), of peridotites (mostly harzburgite and minor lherzolite) and dunite, serpentinized to various degrees; of chromitite; of granitic and rodingitic (granitic or dioritic in appearance and rich in CaO) rocks; and of talc-carbonate rocks. All of these igneous rocks are interpreted as being part of a giant ophiolitic complex, which seems to have been extruded on or under unconsolidated aluminous and siliceous sediments in a eugeosynclinal ocean basin, through a major zone of distensional fractures during Lower Ordovician time. Subsequent orogenic movements are believed to have caused the numerous dislocations observed within and alongside this complex as faults and shear zones, mainly along the highly serpentinized ultramafic facies and the talc-carbonate units. Important movements, particularly along certain thrust faults, resulted in bringing some members of the complex in contact with other members of the complex and with members of adjacent formations, thereby causing an interruption or a repetition in their normal stratigraphic sequence.

A peridotite intrusion, cutting through the argillaceous metagraywackes of the Sutton-Bennett belt, immediately west of the open pit in Asbestos, resulted in the transformation of these nearby metasedimentary rocks, through the action of contact metamorphism, into facies grading from greenschists to amphibolites, as one approaches the peridotite intrusion. In the light of the numerous peridotite intrusions occurring as dikes, sills and lenticular masses in the Thetford-Black Lake area, this small peridotite body which is adjacent to the amphibolite zone at Asbestos is interpreted as a feeder, believed to have supplied this ophiolitic complex with part of its ultramafic magma during its extrusion on the eugeosynclinal ocean basin floor. This peridotite dike and the adjacent amphibolitized metagraywackes appear to have been subsequently brought in faulted contact with the main ultramafic mass of the complex during later orogenic movements.

Several primary natural features suggest that liquid immiscibility is at least partly responsible for the magmatic differentiation that took place under a self-formed roof of mafic volcanics in this ophiolitic complex, thereby contributing to the formation of the various ultramafites (pyroxenites, peridotites, dunite) and the chromitite concentrations (e.g. podiform chromite) locally found in the dunite.

New evidence seems to indicate that the irregular granitic masses which are only found within the ultramafic rocks of this and other ophiolitic complexes are the result of rheomorphism or palingenesis of irregular masses of unconsolidated aluminous and siliceous sediments, which had accumulated on the eugeosynclinal ocean basin floor on which this giant ophiolitic flow was emplaced. According to this new model, blobs of sediments would have been ripped off the bottom of the sedimentary basin by this huge magmatic flow in motion and, in some cases, would have undergone partial or even total fusion while penetrating the hotter and still liquid inner portions of this thick sub-marine volcanic extrusion. This ripping off of wet marin sediments also may have been assisted by their relatively low density at the time, condition which may have contributed in transporting them as irregular masses in an ascending movement within the still partly liquid ophiolitic flow, in a manner similar to that giving rise to salt domes in unfolded terrains. The immiscibility features observed between the granitic masses and the ultramafic rocks (mainly peridotites and dunite) are therefore believed to represent phenomena of partial assimilation or fusion of foreign sialic material having nothing to do with magmatic differentiation proper. One can easily imagine a similar origin for the rodingitic rocks, also found exclusively within the ultramafic rocks of ophiolitic complexes, through rheomorphism or palingenesis of irregular blobs of limy sediments.

The mafic composition of the volcanites bordering this complex seems to be obviously inconsistant with the ultramafic nature of the original magma, as testified by some feeder dikes, particularly west of the Jeffrey pit at Asbestos and in the Thetford Mines area, even though this latter locality belongs to the Thetford Mines ophiolitic complex. Would it not be possible to explain the progressively more felsic composition of the external portions of the Asbestos ophiolitic complex by a quasi-spontaneous diffusion and assimilation of the adjacent wet sediments by the peripheral magma of this giant magmatic flow? I believe far too little is known about the phenomena related to the extrusion of such a submarine flow in a eugeosynclinal environment to categorically deny this possibility. Since this hypothesis was derived empirically, its use as a working tool seems legitimate, even if it requires later modifications.

Moreover, besides providing us with a possible explanation for the origin of the irregular felsic (mostly granitic) and rodingitic masses found within the ultramafites and for the mafic composition of the volcanites associated with ophiolitic complexes throughout the world, the model herein proposed also seems to offer an explanation for the local gradational contact between the mafic volcanites and the adjacent sediments, for the spilitic affinity of the mafic volcanites, for the origin of the irregular felsic (mostly rhyolitic) masses found within these mafic volcanics, for the transitional contacts from the mafic volcanites to the gabbroic rocks to the pyroxenites to the peridotites and dunite and for the (marine) source of the tremendous amount of water required to serpentinize ultramafic masses of that size.

The bulldozing effect that such a huge volcanic flow would have on the unconsolidated argillaceous sediments resting on the floor of this eugeosynclinal trough would also explain the omnipresence of highly chaotic, wildflysch-type, pelitic sedimentary rocks along the southeastern margin (oceanic side) of all the ophiolitic complexes in southern Quebec, the northwestern margin of these complexes being thrustfaulted against the metasedimentary rocks of the Sutton-Bennett belt.

STRATIGRAPHY AND AGE

The Asbestos ophiolitic complex represents the southwestern extension of the Thetford Mines complex (Lamarche[1], 1972). They both rest at the same stratigraphic level as the other ophiolites of southern Quebec: southeast of the older Cambro-Ordovician rocks of the axis of the Green Mountain-Sutton Mountain anticlinorium (also known as the Sutton-Bennett belt in Quebec) and northwest of the younger flysch assemblages of the Saint Victor synclinorium, represented by the Magog group of Middle and Upper Ordovician

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[1] Lamarche, R.Y. 1972, Ophiolites of southern Quebec: in The ancient oceanic lithosphere. v. 42, no. 3, Publ. Earth Physics Branch, Min. Energie, des Mines et des Ressources, p. 65-69.

age. A continuous band of aluminous and predominantly wildflysch-type metasedimentary rocks belonging to the Saint Daniel formation, of Middle or Lower Ordovician (?), separates rocks of the Saint Victor synclinorium from those of the Asbestos complex. The Saint Daniel formation is overlain by the basal beds of the Beauceville formation, which makes up the lower part of the Magog group. These basal Beauceville beds are well dated as Normanskill (Middle Ordovician) from their abundant graptolite fauna, particularly from the Castle Brook locality on the west side of Lake Memphremagog (Berry[2], 1962).

The base of the mafic volcanic member of the Asbestos ophiolitic complex rests either unconformably, directly on the schistose and folded eugeosynclinal metasedimentary rocks of the Sutton-Bennett belt or conformably on an interformational assemblage of eugeosynclinal pelitic rocks*, which are, in turn, resting unconformably on rocks of the Sutton-Bennett belt.

Based on purely stratigraphic data, it is therefore possible to conclude that all rocks of the Asbestos ophiolitic complex, along with those of the other ophiolites of southern Quebec, are younger than rocks of the Sutton-Bennett belt and older than the Middle Ordovician (Normanskill) Beauceville formation, or, in all probability, of Lower Ordovician age.

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[2]Berry, W.B.N. 1962, On the Magog, Quebec, graptolites: Am. Jour. Sci., v. 260, no. 2, p. 142-148.

*Mapped by Cooke[3] (1937) as part of the Caldwell series and by Riordon[4] (1954) as part of the Middle Ordovician Beauceville group (formation in this paper).

[3]Cooke, H.C. 1937, Thetford Disraeli and eastern half of Warwick map areas, Quebec: Geol. Surv. Can. Mem. 211.

[4]Riordon, P.H. 1954, Preliminary report on Thetford Mines-Black Lake area, Frontenac, Megantic, and Wolfe Counties: Quebec Dept. Mines, Prelim. Rept. 295.

Moreover, the ± 480 m.y. K-Ar dates (Poole et al[5], 1963) obtained on granitic rocks contained within the ultramafites of the Thetford Mines area are interpreted as representing a minimum radiometric age for the Thetford Mines ophiolitic complex and, by correlation, for the other ophiolites of southern Quebec, including the one at Asbestos, seeing the granitic rocks are considered as being contemporaneous with the other rocks of the ophiolites. According to Kulp's[6] (1961) and Holmes'[7] (1959) time scales, these radiometric determinations also point to a Lower Ordovician age.

ECONOMIC GEOLOGY

The ultramafic rocks of the Asbestos ophiolitic complex are of great economic importance, for they host several asbestos (chrysotile variety) and chromite orebodies or mineral deposits already mined or presently being mined or explored.

The Jeffrey mine, located right at Asbestos in Shipton township, has been exploited by the Canadian Johns-Manville Co. Ltd. since 1918. This huge orebody, whose proven reserves are said to be in the order of 500 million tons, represents the Western World's largest known asbestos deposit. A large part of the production from this mine was from underground to April 1962, when the operations reverted to open pit only. The annual production at this mine is more than 700,000 tons of fibre, coming from a stockwork of chrysotile veins in serpentinized peridotite. Most of this production

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[5]Poole, W.H., J.R. Béland, and R.K. Wanless 1963, Minimum age of Middle Ordovician rocks in southern Quebec: Geol. Soc. Amer. Bull. v. 74, no. 8, p. 1063-1065.

[6]Kulp, J.L. 1961, Geological time scale: Science, v. 133, no. 3459, p. 1105-1114.

[7]Holmes, A. 1959, A revised geological time scale: Edinburgh Geol. Soc. Trans. v. 17, pt. 3, p. 183-216.

is yielded by cross-fiber veins usually less than 0.5 centimeter and rarely exceeding 2 centimeters in width.

At Saint-Adrien-de-Ham, in Ham Nord township, Wolfe Asbestos and Magnesium Mines Ltd. is reprocessing the tailings from the old Dominion Asbestos operations. It extracts small but apparently economical quantities of asbestos fibers and magnesium-rich powder, selling the latter for the manufacturing of magnesian fertilizers.

The old Nicolet Asbestos Mines Ltd., presently owned by Columbian Holdings, is situated some 6 miles northeast of Asbestos, in Tingwick township. Permanent operations at this mine ceased on January 31, 1969. Like Wolfe Asbestos and Magnesium Mines Ltd., Nicolet Industries, of Pensylvania, recently carried out a feasibility study on the old tailings at the mine site. Results of this study are still not known to the author.

Exploration work is presently being carried out on other asbestos and chromite occurrences within the Asbestos ophiolitic complex. Such is the case for the Lili Asbestos Mines property, near St.Cyr in Cleveland township, which is currently being explored by Pathfinder Resources Ltd. As of September 15, 1972, the company had put down 71,512 feet of diamond drilling, thereby outlining three main zones mineralized in asbestos and which are said to total 49 million tons, according to the company's annual report. It should be mentioned that it was on this property that Sterrett Chromite Mine exploited chromite during the last world war, this mineral having a strategic importance at that time. Another property, located just to the southwest of the one previously described, is presently being explored for asbestos by Celtic Minerals Ltd. They are said to have drilled 16 holes to date on the property (World Mining, February 1973, p. 72).

No interesting nickel or copper sulphide mineralization was found within the area under study. Almost the entire nickel values present in the ultramafites of this complex seem to be tied up in silicate minerals and in a natural nickel-iron alloy called awaruite.