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STUDY OF THE LITHOGEOCHEMICAL AND ND ISOTOPIC DATA FOR THE VOLCANIC AND PLUTONIC ASSEMBLAGES IN THE SOUTHERN PART OF QUEBEC'S FAR NORTH

Study of the lithogeochemical and Nd isotopic data of the volcanic and plutonic assemblages in the southern part of Québec's Far North

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ABSTRACT

The southern part of Québec's Far North (NTS map-sheets 24D, 24E, 23M, 34A, 34H, and 33P) is underlain by several volcanic suites and five major plutonic suites. The latter comprise: 1) the tonalite-trondhjemite-granite (TTG) series composed of ancient orthogneiss (2833-2803 Ma) and foliated and granitized intrusive rocks (2758-2719 Ma); 2) the massive to foliated, megaporphyritic granodiorite series (2714-2683 Ma); 3) the late granite series (2701-2683 Ma); 4) the mafic to ultramafic intrusive rock series (2730-2710 Ma); and 5) the pyroxene-bearing granitoid series (2729-2690 Ma).

Mesoarchean bimodal volcanism (2.88 Ga) associated with a continental rift sequence (e.g., the Vénus volcano-sedimentary belt) gave rise to mafic-ultramafic volcanic rocks and felsic tuffs. The mafic-ultramafic rocks have positive values for εNd_i (+1.47 to +2.47) whereas the felsic rocks have strongly negative values (−1.42 to −1.75). These isotopic signatures for neodymium indicate a juvenile mantle source for the mafic-ultramafic rocks and an origin by direct melting of sialic (tonalitic?) crust older than 3.0 Ga for the felsic rocks.

Foliated to granitized granitoids of the TTG series have Al_2O_3 contents (13.6-18.3 weigth %), Na_2O contents (3.1-5.5 weigth %), and high $[La/Yb]_{CN}$ (1.6-129.1) and Sr/Y (7-232) ratios that are characteristic of the Archean TTG suites' chemical signatures. Except for one trondhjemite sample, all plutons show crustal values for εNd_i (+0.0 to −2.67), well below the evolutionary field for the depleted Archean mantle of the northern Superior. The massive to foliated porphyritic granodiorite series is characterized by intermediate to felsic compositions (SiO_2 = 60.6-75.4 weigth %) and by strong fractionation of the REE ($[La/Yb]_{CN}$ = 10-84). Intrusive rocks of the late granite series display a geochemical signature (e.g., Sr/Y = 57, Zr/Y = 24, and $[La/Yb]_{CN}$ = 94) typical of felsic magmas derived from deep crustal melting (i.e., 35 to 40 km). Taken together with the εNd_i values (+0.45 to −4.43), the chemistry of the porphyritic granodiorite and late granite series points to the melting of a sialic (tonalitic) crust formed between 2811 and 2758 Ma and containing some enriched components older than 3.0 Ga. The isotopic (εNd_i = +0.40 to −1.17) and geochemical (Zr/Y = 3 to 8 and $[La/Yb]_{CN}$ = 3.8 to 11.4) compositions of gabbros and gabbronorites in the mafic to ultramafic series are due either to derivation from a mantle source that had experienced prolonged enrichment in light REE (> 2.8 Ga) or to substantial contamination of mafic magmas by old sialic crust (> 3.0 Ga). Geochemical and isotopic data (εNd_i = −0.27 to −1.90) obtained from the pyroxene-bearing granitoid series seem to indicate that the Alma1b et Alma1c sub-units of the Loups Marins Complex are the high-temperature, anhydrous equivalents of the Desbergères, Maurel (massive to foliated, megaporphyritic granodiorite series), and Tramont (late granite series) suites. However, the Alma1a sub-unit and the Alma2 unit of the Loups Marins Complex are similar to the Coursolles and Favard suites (TTG series).

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Thus, the five plutonic suites generated between 2758 et 2683 Ma have εNd_t values (+0,45 to –4,43) indicative of either melting of an isotopically heterogeneous crust with a component older than 3.0 Ga or substantial contamination of primary magmas by this crustal material. The neodymium isotopic data indicate that the Mesoarchean crust probably did not form from fragments of protocraton to which were added Neoarchean volcano-plutonic and volcano-sedimentary assemblages. Rather, the Mesoarchean crust constituted a larger entity that was strongly recycled during episodes of Neoarchean magmatic episodes.

Mapping projects conducted by the MRNFP in areas poorly known up to the end of the 1990s have led to renewed interest in mining exploration in the Far North. The present geochemical study, complementary to these projects, proposes a new classification for the volcanic and plutonic suites and sheds light on their tectonomagmatic evolution. It also contributes to the evaluation of the mineral potential of the various suites. For example, the late granite series contains monzogranitic plutons generated by melting of deep tonalitic crust; their geochemical signatures exclude the possibility that they contain rare-metal mineralizations corresponding to known models. On the other hand, some pyroxenites and gabbros in the mafic to ultramafic series show chemical variations similar to those of the Ni-Cu-Co-bearing pyroxenites in the Qullinaaraaluk suite.