Geochemistry of Proterozoic (~1.9 Ga) sedimentary rocks from the Labrador district, Canada

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Introduction

Weakly metamorphosed metasedimentary rock samples used in this study belong to Ramah group of Proterozoic. The Ramah group, consisting chiefly of sedimentary rocks distribites along north-south trending synclinal axis in northern Labrador. The Ramah group is considered early Proterozoic on the basis of a Rb-Sr whole rock age of 1.89 Ga (Morgan, 1978), obtained from a basalt lava and related feeder dyke near the base of the group. Approximate total thickness of the group is 1700 m, most component of the group are sedimentary rocks. Volcanic rocks are minor component of the lower sequencre, but numerous diabase sills which intruded the group are known.

The group is subdivided in to six formations (Morgan, 1975; Knight and Morgan, 1977, 1981), Rosell Harbour, Reddick Bight, Nullataktok, Warspite, Typhoon Peak and Cameron Brook formations in ascending order, the dominant lithologies are quartzite, sandstone, mudstone and carbonate rocks.

Samples used in this study are grouped into three categories, black shale, grey shale, and graywacke, from the observation of hand specimens, thin sections as well as from their chemical compositions.

Analytical procedures

Major and certain trace elements have been measured by XRF. FeO contents were separately measured by $KMnO_4$ titration. Mo and U concentrations were measured using neutron activation technique. C and S content were measured using Carlo Elva EA-1108 elemental analyser.

Results and discussions

The metasedimentary rock are generally intermediate to felsic in major element compositions. The black shales are generally lower in TiO_2 (0.3–0.7 wt %), Al_2O_3 (9.5–17.3 wt %), Fe_2O_3(t) (< 1.0wt %) and higher in SiO_2 (64.2–80.8 wt %) and Na_2O (1.8–3.8 wt %) relative to grey shale-greywacke (TiO_2, 0.7–1.7 wt %; Al_2O_3, 9.5–17.3 wt %; Fe_2O_3(t), 3.8–13.9 wt %; SiO_2, 47.9–67.3 wt %; Na_2O, 0.3–1.6 wt %). The CIA values (CIA = $[Al_2O_3/(Al_2O_3 + CaOsil + Na_2O + K_2O)] \times 100$, Nesbitt and Young, 1982) of black shale are constant between 59 and 64 which are apparently lower than those of grey shales (73–80) and most greywackes (55–81). Comparing with the average shale (CIA = 72-75) and deep sea mud (CIA = 69, Nesbitt and Young, 1982), black shales and a part of greywacke in this area are geochemically immature.

The abundances of trace elements such as Ni, Co, Rb, Th and U are lower in black shales. Carbon contents are apparently higher in black shale (1.7-2.8 wt %) than those in grey shale (0-0.3 wt %) and greywacke (0-0.5 wt %). Microscopic observation suggests most carbon in metasedimentary rocks from the study area incorporated in organic materials. Sulfur abundances are apparently higher in black shale (0-0.3 wt %), but its concentration is lower than common modern marine shale (Goldhaber and Kaplan, 1974). The S/C ratio varies between 0 and 0.11 (average 0.04) which is extremely lower than marine shale (S/C = 0.36).

Black shale: TiO_2/Al_2O_3 molal ratio of black shales are very constant between 0.036 and 0.043, although Al_2O_3 content varies from 0.93 to 2.00 mol/kg (Fig.). Concentrations of certain major elements such as TiO_2, Al_2O_3, MgO, K_2O, Fe_2O_3(t) clearly have negative correlation with SiO_2 content. These data suggests that black shale was supplied from a single source having $TiO_2/Al_2O_3 \sim 0.4$, and have been diluted with SiO_2 during sedimentation.

Grey shale and greywacke: TiO_2/Al_2O_3 ratio of greyshale (0.061–0.124) and greywacke (0.049–0.114) varies between felsic igneous rock and near mafic igneous rock regions (Fig.). Although most

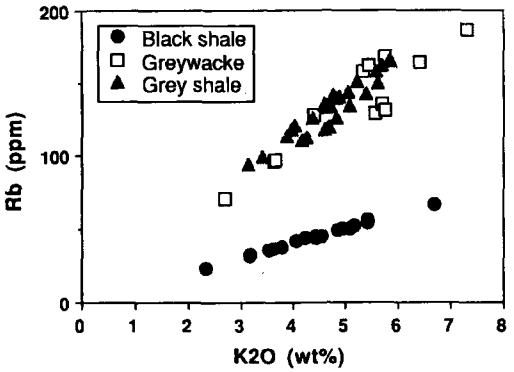

FIG. 1. The relationship between concentrations of K_2O and Rb. Note that two rock series, black shale and grey shale-greywacke, have different elemental ratios.

these metasedimentary rocks are plotted in the intermediate igneous rock region, it is not reasonable to infer that the source rock of them were intermediate in composition, because 1) it is hard to consider the existence of variety of igneous rock in a limited area, 2) grey wacke having high TiO_2/Al_2O_3 ratio (DMH-24) contauns quartz fragments (Fig. 1) which may derived from felsic rock such as granitic rocks. Therefore it is rather reasonable to consider graywacke and grey shale have multiple source; low TiO_2/Al_2O_3 rock mixed with high TiO_2/Al_2O_3 rock during the sedimentation to form rocks of intermediate TiO_2/Al_2O_3 values. Estimation of source rock compositions: TiO_2/Al_2O_3 values were used to calculate tentative chemical compositions of source rocks. Concentration of certain oxide of igneous rocks appeared in the Abitivi greenstone belt are plotted against TiO_2/Al_2O_3 (Fig. 1).

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