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^{87}Sr/^{86}Sr Ratios and δ^{13}C in Early Palaeoproterozoic Marginal Marine, Sabkha and Lacustrine Evaporitic Carbonates, the Canadian and Fennoscandian Shields

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Palaeoproterozoic carbonate rocks in northeastern Canada and southeastern Russian Karelia have been studied to trace second-order variations of the Sr isotopic composition in coeval seawater from the two areas and to define the depositional factors responsible for an extreme ^{13}C enrichment in the Palaeoproterozoic carbonate rocks.

The Palaeoproterozoic (2.17-2.14 Ga) dolomitic Dunphy and Uve formations, and the quartzite-dolomitic Alder Formation represent lower parts of the Knob Lake Group in the Labrador Trough, Canada. The variegated siliciclastic-carbonate Tulomozero Formation in the Onega region, Karelia, represents the upper part of the Jatulian type section (ca. 2.06 Ga). The Tulomozero Formation is subdivided into eight members designated by letters A to H starting from the stratigraphic base. Members B, D, F, G, and H are composed of dolostone interbedded with magnesite. Members C and E consist of quartzite and siltstone with dolomite intercalations. Member A includes red quartzite interbedded with dolostone and limestone. Greenschist facies metamorphism caused slight recrystallisation of the Tulomozero carbonates whereas the Knob Lake dolostones underwent more significant recrystallisation which was accompanied by de-dolomitisation.

The marine palaeo-environments. Both Karelian and Canadian shallow-water marine dolostones contain 50-125 ppm of Sr. The Alder and Uve dolomites with an Fe/Mn ratio of 2.3-7.7 represent distal facies whereas the Tulomozero dolomites (Members G, H and uppermost part of Member B) have a lower Fe/Mn ratio of 0.4-1.6 and represent proximal facies of a shallow-water marine palaeobasin. The δ^{13}C of both Canadian and Karelian marine dolostones varies from +5.3 to +10.2 PDB. The least altered dolomite of the Tulomozero Formation have low both Mn/Sr (<2.0) and ^{87}Sr/^{86}Sr (0.70343-0.70419) ratios. Comparatively, only one dolomite sample from the Knob Lake Group (with the lowest Mn/Sr ratio of 2.7) has a ^{87}Sr/^{86}Sr ratio of 0.70479, approximating the values of the Tulomozero Formation. The strontium isotope ratios obtained from both study areas are considered to represent the isotopic compositions of coeval Palaeoproterozoic seawater.

The partly restricted palaeobasins (ancient equivalent of sabkha). Tulomozero dolomites which formed in these paleoenvironments contain up to 250 ppm of Sr, have a lower Fe/Mn (0.05-0.45) ratios and a higher δ^{18}O values (by 1.5 on average) as compared to marine dolomites. The δ^{13}C values range between +8.0 and +9.0 PDB. In the least altered Tulomozero dolomites (Member D) high Mn and Fe contents (up to 1600 and 800 ppm, respectively) are coupled with a low ^{87}Sr/^{86}Sr ratio (0.70499-0.70534) suggesting that the depositional basin was affected by continental inflow and was episodically connected with an open sea.

The lacustrine evaporite palaeo-environments. The Tulomozero calcites and dolomites (Members A and B) formed in such environments have very high Sr content (up to 2080 and 530 ppm, respectively) and a low Fe/Mn ratio (<0.40) suggesting the presence of sulfates in original deposits. δ^{18}O values measured from the Dunphy dolomites and Tulomozero dolomite and calcite (Members A and B) are higher by 1.5-2 as compared to the marine dolomites from the same formations. δ^{13}C values range between +10.8 and +15.4 PDB. Values of the Tulomozero limestones (Member A) are characterised by ^{87}Sr/^{86}Sr fluctuating between 0.70827 and 0.70871 whereas dolomites (Member B) exhibit less radiogenic values, 0.70643-0.70668. Only one dolomite sample from Dunphy with the lowest Mn/Sr ratio (3.8) yields a similar ^{87}Sr/^{86}Sr ratio of 0.70666. The geochemical parameters obtained have been assigned to carbonates which formed in restricted, evaporitic, coastal lakes or ponds. As follows from this study, the ^{87}Sr/^{86}Sr ratio in 2.17-2.06 Ga seawater ranged between 0.70343-0.70419. The ^{87}Sr/^{86}Sr ratios obtained are too low to support the earlier suggestions that the positive shift in δ^{13}C of Palaeoproterozoic carbonates could have been driven by an accelerated erosional rate causing an exceptionally high accumulation of organic material. Therefore, the latter process could not be responsible alone for the high δ^{13}C values in 2.17-2.06 Ma carbonates. As the δ^{13}C values of carbonates from restricted shallow-water, stromatolitic and evaporitic intracratonic settings are always higher than in marine carbonates, local factors are considered to play an important role in the formation of ^{13}C-rich carbonates.

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