Behaviour of C, O, Sr, Nd and Pb isotopes in high-grade metacarbonate rocks

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Tectonic environment of metasedimentary sequences deposit in orogenic belts is of importance in understanding the formation and evolution of supercontinents. In particular, chemically deposited carbonate rocks are supposed to hold key information of extinct paleo-oceans, since they are directly precipitated from seawater. In this study, we carried out a comprehensive trace and rare earth element analysis, carbon, oxygen, strontium, neodymium and lead isotope measurements in metacarbonate rocks from the Highland Complex, Sri Lanka. The isotopic systems studied have distinct residence and mixing time in seawater, and are also controlled by the input from surrounding continents. We present here the behaviour of each isotopic system with respect to different processes right from the deposition of carbonate from the seawater through diagenesis and then prograde and retrograde metamorphism. TheProterozoic basement of Sri Lanka is subdivided into four lithotectonic units, namely, the Highland Complex (HC), the Wanni Complex (WC), the Vijayan Complex (VC), and the Kadugannawa Complex (KC), based on Nd isotope model ages. The HC is mainly composed of metasedimentary rocks (granulite facies metaquartzites, metapelitic gneisses and metacarbonate rocks), whereas exposures of the WC and the VC are mainly metaigneous rocks. The metacarbonate rocks in the HC generally occur as layers parallel with other metasedimentary lithological units, and show a NE trend.

We measured oxygen and carbon isotope ratios to understand the effect of diagenetic to metamorphic alterations, which can be recognized in negative isotope shifts. In general, the metacarbonate rocks have positive oxygen isotopic composition comparable with the Proterozoic unmetamorphosed carbonates, suggesting that these rocks were not affected by external fluids during digenesis, dolomitization or metamorphism. However, some of the rock units have been affected by later fluid infiltration as seen in major shifts in oxygen isotopic composition. Negative shifts in both carbon and oxygen isotopes correspond to the metamorphic decarbonation reactions being prominent. Strontium isotope chemostratigraphy was applied for the selected samples with least signatures of alteration. The depositional ages show a younging direction of sedimentation from the Wanni-side to the Vijayan-side. In the case of Nd isotopes, the values correspond to variable mixing of continent derived and oceanic crust derived components during carbonate deposition. This is clearly depicted in the ε Sr vs. ε Nd cross-plots where typical seawater-rock mixing relationship in metacarbonate rocks associated with continents and oceanic crusts can be deduced.Pb isotopic composition of the metacarbonate rocks in Sri Lanka indicated significant differences within the HC; the Vijayan side is more radiogenic than that of Wanni side. This might be due to the difference of initial composition, as well as the relationship to depositional basin and seawater composition. We also observed very low U/Pb ratios, which are considered to have occurred due to the U-loss during metamorphic recrystallization.Thus, the Sr-Nd-Pb isotopic composition in metacarbonate rocks suggests interaction between the oceanic crust and carbonate rocks on the Wanni side whereas on the Vijayan side, carbonate sedimentation was accompanied by interaction with cratonic continental crust.Thus, by applying a multi-element isotope geochemical approach on metacarbonate rocks collected from continental collisional zones, and by comparing the data with basement rocks from various neighbouring Gondwana continents, regional affinities could be established.

Sr, Nd and Pb isotopic compositions provide important information about the depositional settings of sedimentary rocks and provide key information about the surrounding terrains of oceanic and continental affinities during the time of deposition. This can lead to a better understanding of paleo-tectonic settings of crustal fragments that assemble to form supercontinents.

Keywords: metacarbonates, Sr-Nd-Pb isotopes, Sri Lanka

