A new geochemical proxy for supercontinent reconstruction: low δ18O magma

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Magmatic rocks with $\delta^{18}O$ values significantly lower than normal mantle-derived magmas are rare in earth histories. While there is only negligible oxygen isotope fractionation during partial melting and magma differentiation, theoretical calculation suggests that high-T hydrothermal alteration by surface water (seawater or meteorite water) is the only effective way to significantly decrease the oxygen isotope ratios of silicate rocks. Decades of studies on low $\delta^{18}O$ magmas have demonstrated that all of them are formed through partial melting of low $\delta^{18}O$ rocks or assimilation of normal $\delta^{18}O$ magmas by low $\delta^{18}O$ rocks. This means that the development of low $\delta^{18}O$ magma requires the coincidence of widespread surface water with low $\delta^{18}O$ values which is linked with paleogeography, intensive high temperature alteration and contemperaneous magmatism in upper crust. These harsh terms suggest that low $\delta^{18}O$ magma with similar ages can be used as a proxy for supercontinent reconstruction.

This proxy is demostrated to be successful in the reconstrucion of Rodinia. In the north margin of South China, a low $\delta^{18}O$ magma belt is identified by a series of sudies. Although the rocks in the northeastern margin of South China suffered high-degree metamrophic overprint, most of the mafic and felsic protoliths of theses metamorphic rocks are variably depleted in ^{18}O and have zircon U-Pb ages of 740-780 Ma. Recent new results suggest that similar low $\delta^{18}O$ granites and rhyolites with similar ages also occurred in the middle and western part of the north margin of SC. This low $\delta^{18}O$ magma belt extends for more than 1600 Km and differs with magmatic rocks earlier than 800 Ma in SC. Low $\delta^{18}O$ magmas were also reported in some plutons along the western margin of SC whereas it is absent in the south and east margin. Similar $\delta^{18}O$ granites and rhyolites with similar ages were reported in Madagascar, Seychelles and NW India, suggesting that they were located together in supercontinent Rodinia. This is consistent with other evidences based on geological and paleomagnet studies. Application of this proxy in other continents of Rodinia and other supercontinent, e.g., Pagaea, will provide more tests on it.