Constraining the Thermal History of an Ultra-hot Orogen from Metamorphic Reaction History and Garnet-Orthopyroxene Diffusion Modelling Studies

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The southern margin of the Central Indian Tectonic Zone experienced a history of metamorphism at different sets of conditions during the Proterozoic. A primary, high temperature assemblage of aluminous orthopyroxene (X_{Mg}= 0.585) + calcic plagioclase (An_{49-52}) + magnesian ilmenite (X_{MgTiO3} = 0.06-0.07) experienced three recrystallization events (M_1 with a T_{Max} of ~1000 °C at 9.5 kbar and M_2 at 900°C, 6.7 kbar and M3 at 770°C, 7.5 kbar) to produce two generations of garnet, orthopyroxene and biotite. We have integrated observations on metamorphic reaction textures, mineral compositional zonation, calculated pseudosections, available geochronological data, and diffusion modelling of compositional profiles in garnet and orthopyroxene to constrain the timescale of thermal evolution for this complex sequence. We find that at least a three stage thermal history is necessary to account for all observations consistently. Cooling rates on the order of 10's of °C/ my indicate that high temperatures of M_{1-3} metamorphism were sustained for tens of million years, providing evidence of a long lasting (i.e. > 60 my) regional metamorphic event.

The origins of detrital clays on the East China Sea shelf

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There are two kinds of sediment source-to-sink (S2S) systems on the East China Sea shelf. One is "large river/delta – wide shelf – huge input – slower sediment transfer – strong anthropogenic impact" represented by the Changjiang (Yangtze) River; another is "mountainous river – narrow shelf – huge input – rapid sediment transfer – extreme climate event" represented by the rivers in Taiwan Island. To study the contributions of these two S2S systems to clayey sediments accumulated on the shelf, a total of 66 clay samples were selected from the shelf, the Changjiang and mountainous rivers entering the East China Sea. A multivariate analysis technique (EOF) was used to process elemental geochemical data.

The covariance between elements explained by the first two eigenmodes is about 76%. The first mode can explain about 62% of the data variability, in which elements are divided into two groups according to the sign of their eigenvectors. One group is dominated by Ca, Fe, Mg, Mn, P, Co and another by Al, Si, K, Na, Ti and REE. We interpret Mode 1 to be different clay mineral assemblages in the source areas. The second mode can explain about 14% of the data variability. One group consists of K, Na, Rb and LREE while the other elements belong to another group. Mode 2 probably indicates the proportion of non-clay minerals in the clay sediments. Based on the corresponding eigenweights of each sample, the spatial distribution patterns of the clays were revealed. The clay from the Changjiang River was primarily transported southeastward and formed an inner shelf mud belt that mixes with the Taiwan-derived clays in northern Taiwan Strait. Some clay from the Changjiang River may disperse eastward and mix with the clay sourced from the old Yellow River delta in the southwestern Yellow Sea. The oceanic circulation in the East China Sea predominately controls the dispersal and deposition of detrital clays on the shelf.

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