Raman carbonaceous material thermometry applied to mapping the thermal structure of contact metamorphic domains in the Hongusan area, central Japan incorporating the effects of widespread detrital carbonaceous material

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Raman carbonaceous material thermometry (RCMT) can be applied to a wide range of lithologies and over a wide temperature range of 150–655 ˚C. The utility of this method opens the possibility of determining the thermal structure of metamorphic domains with unprecedented spatial resolution. RCMT is based on averages of numerous measurements in a single sample and a potential complicating factor is the presence of detrital carbonaceous material that can bias the average values. Such detrital grains are commonly recognized as grains of highly crystalline CM (close to graphite) amongst grains of lower crystallinity. Recent studies in the Himalayas and Taiwan have shown that the material cycling process in convergent plate margins leads to the storage of highly crystalline CM in sediment because it is relatively resistant to weathering and erosion processes. The existence of detrital CM needs to be assessed to estimate appropriate temperatures and errors using the RCMT. However, there are few studies where the effects of detrital material have been quantitatively studied. Application of RCMT to relatively low-grade metamorphic rocks (< ˜400 ˚C) can easily detect the presence of detrital CM because of a crystallinity gap between weathering-resistant high-grade CM and lower-grade metamorphic CM. However, it is unknown whether detrital and metamorphic CM can be clearly distinguished in higher-grade metamorphic domains. It is also not clear whether detrital grains of CM with crystallinity less than graphite can also be present. In the Hongusan area of Aichi Prefecture, two distinct types of thermal structures can be recognized: firstly one associated with the regional high-*T/P* type Ryoke metamorphism, and secondly later overprinting contact metamorphism recognized around two separate granitic intrusions. Application of the RCMT to 100 metamudstone samples in the study area reveals that several samples show multimodal crystallinity of CM which indicates the existence of a large amount of detrital CM grains including both fully crystallized graphite and lower crystallinity metamorphic CM grains. A new procedure was developed to filter out the effects of detrital CM and assist in determining the metamorphic thermal structure. The results clearly show the distinct thermal structures related to regional and contact metamorphism with a high spatial resolution that can be used to determine the extent of the contact metamorphism. The estimated temperatures show good agreement with a more limited data set obtained using silicate equilibria models. Spatial changes in the distributions of the metamorphic and detrital CM clearly show that as the maximum temperature increases, CM with low crystallinity progressively transforms to graphite and multiple crystallinity peaks gradually merge to one at a high grade. These results show RCMT can be used to derive detailed and reliable temperature estimates even if the original metasedimentary rock contains a significant amount of detrital CM. The recognition of detrital CM can be used to infer the grade of metamorphic rocks present in the hinterland that supplied the detritus of the Mino–Tanba belt. This approach can be added to the tools used in the provenance analysis of sedimentary rocks. The contact aureole around the Shinshiro tonalite in this area is remarkably thick and may reflect the tectonic setting during magma emplacement or the cooling process of magma. The formation process may be constrained by considering the thermal model and the obtained Raman CM temperature.

Keywords: Raman carbonaceous material thermometry, Detrital carbonaceous material, Metamorphic temperature mapping, Ryoke metamorphic belt