High-precision temperature change at the western Japan during the past 10,000 years and its effect on the human activity

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A continuous record of terrestrial environments is difficult to reconstruct because terrestrial sediments are often eroded and transported away by wind or water. In contrast, marine sediments often provide a continuous record of both marine and terrestrial environments in their sedimentary sequence. Therefore, we collected a shallow-marine sediment cores near Hiroshima-city, located near Inland Sea of Japan in the western Japanese Islands, and conducted the reconstruction of Holocene environmental change with ultra-high resolution of environmental change during 700-1700 AD. SST (sea surface temperature) declined (26.2-23.7oC) from 10,300 to 3,900 cal. Yr. BP), which is quite different from those recorded in surrounding areas including Yellow Sea, Japan Sea, and the western Pacific, which show increase in SST or a maximum around mid-Holocene. We attributed the decrease in SST to the large heat capacity of Inland Sea of Japan and general decrease in insolation. SST fluctuated between 22.3 and 24.3 during 1900BC-1800AD). With respect to historical record, Asuka (592-610AD) and Nara (710-794AD) eras showed reduced and enhanced SSTs, respectively. The former half of Heian era (794-1000AD) showed very mild and optimal climate, which enabled aristocracy by noblemen. In contrast, SST drastically declined from the latter half of Heian era to majority of Kamakura eras (1000-1230AD), which could promote the change to Samurai government by power politics. After that a relative mild climate prevailed about 200 years (1230-1500AD) and then cold weather was observed during 1500-1800AD, corresponding to Little Ice Age.

Melt inclusions in zircon from the migmatite zone, Ryoke belt, Japan

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Melt inclusions in Zrn is a clear evidence of the presence of melt during Zrn formation and therefore, places an important constraint on the timing of Zrn growth. In the Ryoke belt at the Aoyama area, Japan, pelitic and psammitic schists dominate in the north, and migmatites dominate in the south [1]. Zrn in pelitic and psammitic schists from the low-T part of the Grt-Crd zone is coarse-grained and shows almost no syn-metamorphic overgrowth. On the other hand, Zrn in migmatites from the mid-T and high-T parts of the Grt-Crd zone has thin, bright annulus under BSE image along which tiny inclusions of several microns are aligned [cf. 2]. TEM observation of the inclusions gave halo patterns, revealing that they are glass rich in Si, Al and K. This inclusion alignment divides the Zrn into the core with various detrital ages and the rim with 92.6±2.0Ma ^{206}Pb/^{238}U concordant age. Presence of the melt inclusions at the core/rim boundary shows that the melt was present when the Zrn rim grew. Low Th/U ratio (<0.02) of the Zrn rim implies that Mnz also coexisted then. A reaction Bt+Sil+Qtz = Grt+Crd±Kfs±Ilm+melt is considered responsible for partial melting in this area [1]. However, Bt is not an important sink of Zr [3], and Bt breakdown cannot supply sufficient Zr to form Zrn rim. Therefore, dissolution of pre-existing Zrn is required to grow new Zrn rim. It would be difficult to saturate melt in Zrn component by dissolving Zrn when the amount of melt is increasing. Therefore, 92.6±2.0Ma Zrn rim probably crystallized during the solidification of the melt in migmatites, possibly near the wet-solidus. Thin, similar-aged rim is developed in Zrn from the mid-T part as well. These data suggest that presence of the melt controls dissolution and recrystallization of Zrn [e.g. 4].

Although the whole-rock Zr content is not especially high in the pelitic-psammitic schists from the low-T part, modal amount of Zrn (>20μm) is higher in them. Zrn (<20μm) is confirmed to become common in mid-T and high-T parts, and young, ca. 30μm Zrn without detrital core are rarely found in the high-T part. These Zrn are probably newly nucleated grains during the Ryoke metamorphism.

On the other hand, Mnz grows at amphibolite facies grade and the presence of the melt does not largely affect its recrystallization [4]. In the Aoyama area, Mnz from the migmatites records the prograde growth age of 96.5±1.9Ma during the regional metamorphism [5]. Using the difference of growth timing of Mnz (prograde) and Zrn (retrograde), the duration of metamorphism higher than the amphibolite facies grade can be constrained to be ca. 4Ma for the Ryoke metamorphism at the Aoyama area.

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