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Tectonic erosion and geotectonic evolution of the Japanese Islands

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The ca. 700 million year-long geotectonic history of the Japanese Islands comprises three distinct intervals; i.e., 1) the age of a passive continental margin off the South China continental margin (ca. 700-520 Ma), 2) the age of an active margin characterized by an arc-trench system (ca. 520-20 Ma), and 3) the age of an island arc off East Asia (20 Ma to the present). These three intervals are chronologically separated by two major boundaries with significant tectonic episodes; i.e., the ca. 520 Ma tectonic inversion from a passive to an active margin by the initiation of subduction from the Pacific side, and the ca. 20 Ma tectonic isolation of the modern island arc system from the Asian margin by the back-arc basin (Japan Sea) opening. Here, the evolutionary history of the Japanese Islands is revised significantly on the basis of new lines of information that derived from a new dating technique of detrital zircon in sandstone. Particularly noteworthy is the recognition of the Early Paleozoic to Middle Mesozoic arc batholiths that were exposed extensively in the past but not at all at present because the pre-Cretaceous granites merely occur as kilometer-size blocks in the modern Japanese Islands. As to these older granites, the remarkable disagreement between the current distribution and the predominance of their clastic grains in younger sandstones suggests the effectiveness of past tectonic erosion processes in the fore-arc domains. The newly documented historical change in sandstone provenance suggests that proto-Japan has experienced not only accretionary growth but also large-scale tectonic erosion in multiple stages. During the ca. 500 million-year history of the Japanese Islands, a large amount of juvenile arc (continental) crust was formed several times, however, most has already disappeared from the surface. In short, the orogenic growth of Japan, even in a long-lasting active continental margin setting, is explained as the intermittent repetition of ocean-ward continental growth and continent-ward contraction of an active arc-trench system.

In contrast to these arc batholiths, the terrigenous flux from the neighboring two major continental blocks (South and North China) was less significant than previously imagined, except for the Jurassic to Early Cretaceous time when the collisional suture between North and South China blocks was selectively eroded to produce abundant terrigenous clastics. It is also significant that the eastern extension of this collisional suture was recognized in Japan as a chain of fragmentary remnants of the Triassic medium-pressure metamorphic belt. On the basis of these new lines of information, the South China-related origin of the main part of Japan is confirmed, whereas the Hida and Oki belts along the Japan Sea are identified as detached fragments of North China block. Summarizing all of these results, a series of paleogeographic maps of Japan from the Late Neoproterozoic to the Miocene is revised and illustrated.

Keywords: Japanese Islands, accretion, granite batholith, detrital zircon dating, tectonic erosion, arc crust