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Mode of Reciprocal Continental Growth and Shrinkage in a Pacific-Type Orogen: A New Template from Japan

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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. The evolutionary history of the Japanese Islands was recently revised significantly on the basis of new lines of information from new detrital zircon chronology for sandstones. Particularly noteworthy is the first recognition of the Paleozoic to mid-Mesozoic granitic batholith belts that were once exposed extensively but not at all at present. At present, the major batholiths in Japan all belong to Upper Cretaceous to Cenozoic, whereas pre-Cretaceous granites merely occur as blocks of no larger than km size. Nonetheless, all Middle-Upper Paleozoic sandstones are dominated by the Early-Middle Paleozoic (500-400 Ma) igneous zircons, and the Triassic-Low Cretaceous sandstones by the Late Paleozoic-mid-Mesozoic (300-150 Ma) grains, respectively. This remarkable disagreement between the currently exposed granites and the dominance of older remnants in younger sandstones clearly demonstrates the effectiveness of tectonic erosion that took place in the Paleozoic-Mesozic fore-arc domain of Japan. In short, the provenance change throughout the Phanerozoic suggests that proto-Japan has experienced not only accretionary growth but also large-scale tectonic erosion in multiple stages. During the last 500 m.y., a large amount of juvenile arc (continental) crusts was formed several times; however, most of them already disappeared from the Earth's surface. We conclude that huge amounts of granitic continental crust can surely subduct into mantle from active margins, thus "continents are not forever".

The orogenic growth of Japan is simply summarized as the reciprocal ocean-ward continental growth and continent-ward contraction within the same long-lasting active continental margin setting. Besides these arc batholiths, the terrigenous flux from the neighboring two major continental blocks (South and North China) with older crusts 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. The abundance of these continent-derived older zircon grains is more than noteworthy; a remarkable contrast exists among the coeval arc-related sandstones, i. e. trench-fill turbidite sandstone, HP-metamorphosed psammitic schist, fore-arc and back-arc sandstones. The difference in abundance was driven likely by two tectonic processes, i.e., "tectonic erosion" along the Wadati-Benioff zone, and formation of "batholith barrier" in the mid-arc surface. These unique features recognized in Japan can serve as a template to analyze/describe other sudduction-related orogens in the world even formed under different time-space frameworks.

Key words: Pacific-type orogeny, subduction, accretion, tectonic erosion, Japan

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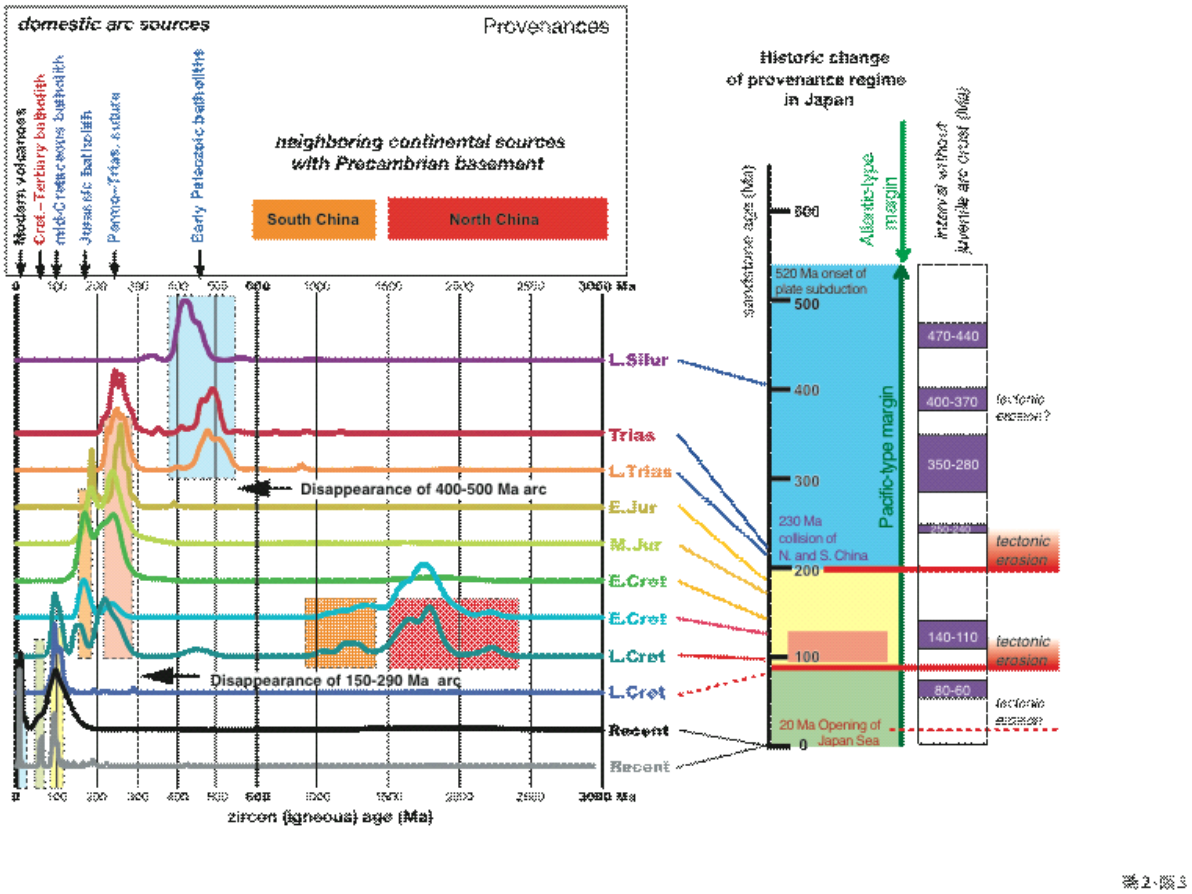

Fig. 1. Secular change in age spectruam of detrital zircon form the Phanerozoic orogenic sandstones in Japan (Isozaki et al., 2010). Note that the once-dominant Early Paleozoic to mid-Mesozoic granitic provenances disappeared in multiple steps likely through ?tectonic erosion? within the same Phanerozoic active continental margin of Japan.

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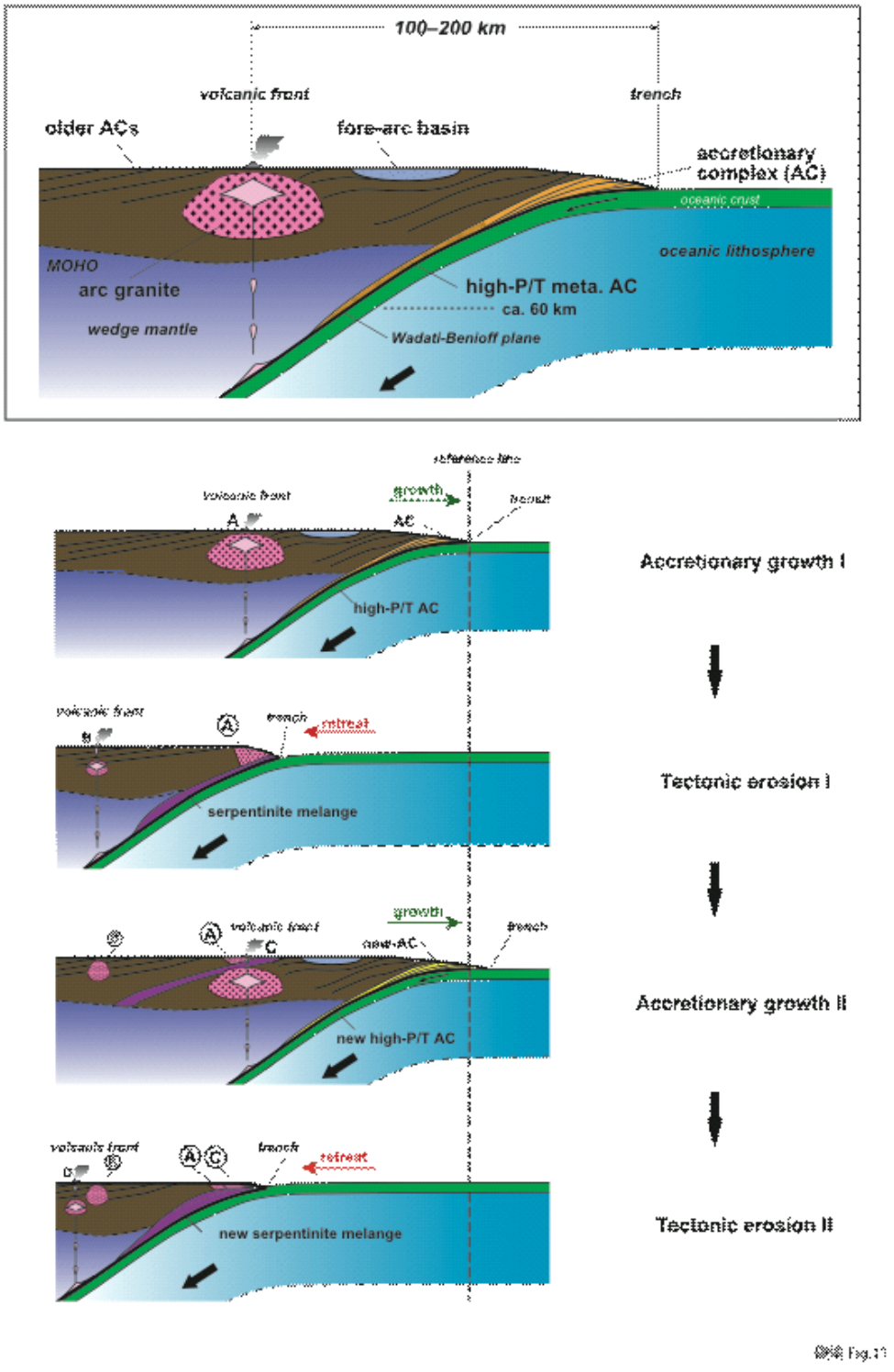

Fig. 2. Reciprocal oceanward growth and continentward shrinkage of an active continental margin.