



ASIAN CONTINENT: ITS ORIGIN, FORMATION, AND GROWTH

The Asian continent, occupying the greatest portion of Eurasia, is the largest and the youngest continent of the seven continents on Earth. The main portion of the continent was formed by the amalgamation of the Siberian Craton with a series of Peri-Siberian terranes and several cratons/microcontinents that surrounded the Gondwana supercontinent (Li et al. 2018). The amalgamation lasted until the early Mesozoic and produced the Proto-Asian continent. The collision of part of Gondwana (i.e., India with Sri Lanka) with Proto-Asia completed the geologic and climatic frameworks present in Asia during the Cenozoic. However, except for India, China, Korea, and Japan, there are still many geologically obscure terranes that make up the Asian continent.

Putting aside the Paleoproterozoic events that affected each craton/microcontinent, the Asian orogenies are mainly divided into four stages, all of which are accompanied by low- to high-grade metamorphism: (1) The Late Neoproterozoic to early Cambrian, the so-called Pan-African Orogeny that affected the Gondwana fragments; (2) the Ordovician–Silurian orogeny that is preserved in the microcontinents from the Gondwana margin; (3) the Permian–Triassic orogeny, which is related to the formation of the Proto-Asian continent; (4) the Paleogene–Neogene orogeny, which produced final main growth and deformation of Asia.

Our research group has conducted comprehensive analyses of metamorphic rocks because they precisely record the tectonic evolution of the geologically obscure Asian terranes. These analyses allowed us to realize where the Asian cratons/microcontinents came from, where the boundaries among the cratons/microcontinents are, what happened during the formation of the Asian continent, and where the Asian continent is headed in the future. Because the Asian continent is the youngest continent on the Earth, the rocks preserve a lot of information, which suggests that the detailed evolution of the Asian continent will be a useful analog not only for supercontinent formation and breakup but also for continental growth during Earth history.

Over the past 15 years, we have performed fieldwork in metamorphic terranes from Japan, Mongolia, southern Russia (Baikal region), Vietnam, Lao, Thailand, Myanmar, Indonesia, Timor-Leste, Southwestern China (Sanjiang region), Sri Lanka, and Afghanistan. We have also analyzed various types of macro- to micro-scale textures (Fig. 1). Comprehensive analyses of rocks formed at specific pressure–temperature conditions—eclogite facies rocks (Nakano et al. 2010); granulite facies rocks (Osanai et al. 2016a, b); blueschist facies rocks (Yoshimoto et al. 2013); rocks with unusual protoliths, such as bauxite (Nakano et al. 2018); hydrothermally altered rocks (Nakano et al. 2014)—provide critical information about the tectonic environment before, during, and after the formation of the Asian continent. Consequently, various types of metamorphic rocks are included in the scope of our study.

The widespread distribution of the metamorphic rocks, including high-pressure and high-temperature rocks, suggests the position of past plate boundaries between the cratons/microcontinents. The pressure–temperature–time evolution allows us to interpret the timing of the collision as well as physical and chemical conditions and/or phenomena in each plate convergence. Additionally, analyses of the protolith of the meta-igneous rocks give us the tectonic evolution prior to metamorphism. Likewise, detrital zircon provenance in meta-sedimentary rocks is one of the most effective tools to understand their source terranes. We also used monazite (Nd isotopes) and detrital apatite (Sr isotopes) geochronology to better understand the source of the metamorphic rocks and to figure out the puzzle of how the various microcontinents are related to the formation of the Asian continent.

Recently, we have also started applying these comprehensive analyses to archeological materials involving earthenware, stone and metal

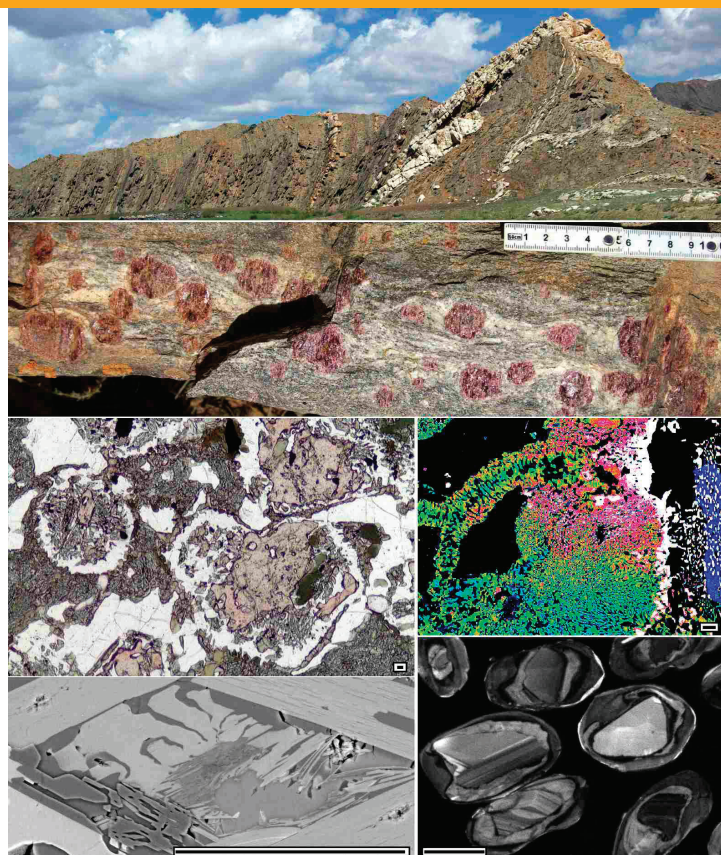


FIGURE 1 Macro- and micro-scale textures of metamorphic rocks in Asia. All scalebars in the lower four photomicrographs correspond to 50 μ m.

tools, and human skeletal remains. We do this in collaboration with archeological institutes in Japan, Korea, Taiwan, Mongolia, and Russia to understand human migration and intercommunication in Asia. Hence, our research is expanding into the field of human history. The final, overall, goal is to fully understand the tectonic evolution of the Asian continent and the evolution of humanity on the Asian continent.

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