



Geology and tectonics of Japanese islands: A review – The key to understanding the geology of Asia



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ARTICLE INFO

Article history:

Available online 24 May 2012

Keywords:

Japan
Japanese Islands
Geology
Tectonics
Accretion
Metamorphism
Plutonism
Back arc
Collision

ABSTRACT

The age of the major geological units in Japan ranges from Cambrian to Quaternary. Precambrian basement is, however, expected, as the provenance of by detrital clasts of conglomerate, detrital zircons of metamorphic and sedimentary rocks, and as metamorphic rocks intruded by 500 Ma granites. Although rocks of Paleozoic age are not widely distributed, rocks and formations of late Mesozoic to Cenozoic can be found easily throughout Japan. Rocks of Jurassic age occur mainly in the Jurassic accretionary complexes, which comprise the backbone of the Japanese archipelago. The western part of Japan is composed mainly of Cretaceous to Paleogene felsic volcanic and plutonic rocks and accretionary complexes. The eastern part of the country is covered extensively by Neogene sedimentary and volcanic rocks. During the Quaternary, volcanoes erupted in various parts of Japan, and alluvial plains were formed along the coastlines of the Japanese Islands. These geological units are divided by age and origin: i.e. Paleozoic continental margin; Paleozoic island arc; Paleozoic accretionary complexes; Mesozoic to Paleogene accretionary complexes and Cenozoic island arcs. These are further subdivided into the following tectonic units, e.g. Hida; Oki; Unazuki; Hida Gaien; Higo; Hitachi; Kurosegawa; South Kitakami; Nagato-Renge; Nedamo; Akiyoshi; Ultra-Tamba; Suo; Maizuru; Mino-Tamba; Chichibu; Chizu; Ryoke; Sanbagawa and Shimanto belts.

The geological history of Japan commenced with the breakup of the Rodinia super continent, at about 750 Ma. At about 500 Ma, the Paleo-Pacific oceanic plate began to be subducted beneath the continental margin of the South China Block. Since then, Proto-Japan has been located on the convergent margin of East Asia for about 500 Ma. In this tectonic setting, the most significant tectonic events recorded in the geology of Japan are subduction–accretion, paired metamorphism, arc volcanism, back-arc spreading and arc–arc collision. The major accretionary complexes in the Japanese Islands are of Permian, Jurassic and Cretaceous–Paleogene age. These accretionary complexes became altered locally to low-temperature and high-pressure metamorphic, or high-temperature and low-pressure metamorphic rocks. Medium-pressure metamorphic rocks are limited to the Unazuki and Higo belts. Major plutonism occurred in Paleozoic, Mesozoic and Cenozoic time. Early Paleozoic Cambrian igneous activity is recorded as granites in the South Kitakami Belt. Late Paleozoic igneous activity is recognized in the Hida Belt. During Cretaceous to Paleogene time, extensive igneous activity occurred in Japan. The youngest granite in Japan is the Takidani Granite intruded at about 1–2 Ma. During Cenozoic time, the most important geologic events are back-arc opening and arc–arc collision. The major back-arc basins are the Sea of Japan and the Shikoku and Chishima basins. Arc–arc collision occurred between the Honshu and Izu-Bonin arcs, and the Honshu and Chishima arcs.

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1. Introduction

The international geological map of Asia at the scale of 1:5,000,000 (IGM5000) will be completed in 2012. The map is the output of a project of the Commission for the Geological Map of the World (CGMW), organized by Ren Jishun of the Chinese Academy of Science, Institute of Geology. This geological map covers most of the Eurasian continent from Japan in the east, to Turkey in the west.

This new geological map is epoch-making, and will be the most useful map for geoscientists and other users who wish to understand the geology and tectonics of Asia. This special issue is designed to help users understand easily the geology and tectonics of the Eurasian region. The author of this article is the compiler of the geological map of Japan, and the project leader for Region V, which covers Japan, the Philippines, Malaysia, Indonesia and the offshore areas of East and Southeast Asia. Hence, he has a responsibility to explain the geology of Japan as presented in this paper.

The geological units in the Japanese Islands were reviewed by Isozaki et al. (2010a,b), while the tectonic history of the country in the

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Phanerozoic era was described by Isozaki et al. (2011) and Maruyama et al. (2011). Maruyama et al. (1997) have illustrated the paleo-geographic changes since 750 Ma. The author recently compiled a digital geological map of Japan at a scale of 1:200,000, summarizing the country's regional geology, based on the results of recent research (Wakita et al., 2009). It has been made accessible online as a digital geological map (<http://riodb02.ibase.aist.go.jp/db084/>). In this paper, the author reviews the geology and geological history of Japan, based on these recent geological documents, which have provided a valuable input to the International Geological Map of Asia (IGMA500).

2. Ages of the major geological units

The geology of Japanese Islands is extremely complicated (Fig. 1). The rock types distinguished on the map are unconsolidated sedi-

ments, sedimentary, igneous and metamorphic rocks. Ages of major geological units represented range from Cambrian to Quaternary. The clearly identified Precambrian rocks are gneiss of the clasts in the Kamiaso conglomerate in the Jurassic accretionary complex of the Mino Belt (Adachi, 1971; Shibata and Adachi, 1974). The existence of a Precambrian basement is inferred, as the provenance of the sedimentary and metamorphic rocks of the Hida and Mino belts. The metamorphic rocks of the Higo and Hitachi belts intruded by 500 Ma granites (Tagiri et al., 2011) are possible candidate of the Precambrian basement. Recently, the Cambrian sedimentary rocks were found in the Hitachi Belt (Tagiri et al., 2010, 2011). On the other hand, the youngest sediments and volcanic rocks can be found all over the country in alluvial plains and as active volcanoes. Although rocks of Paleozoic age are not widely distributed, rocks and formations of late Mesozoic to Cenozoic can be found easily all over Japan

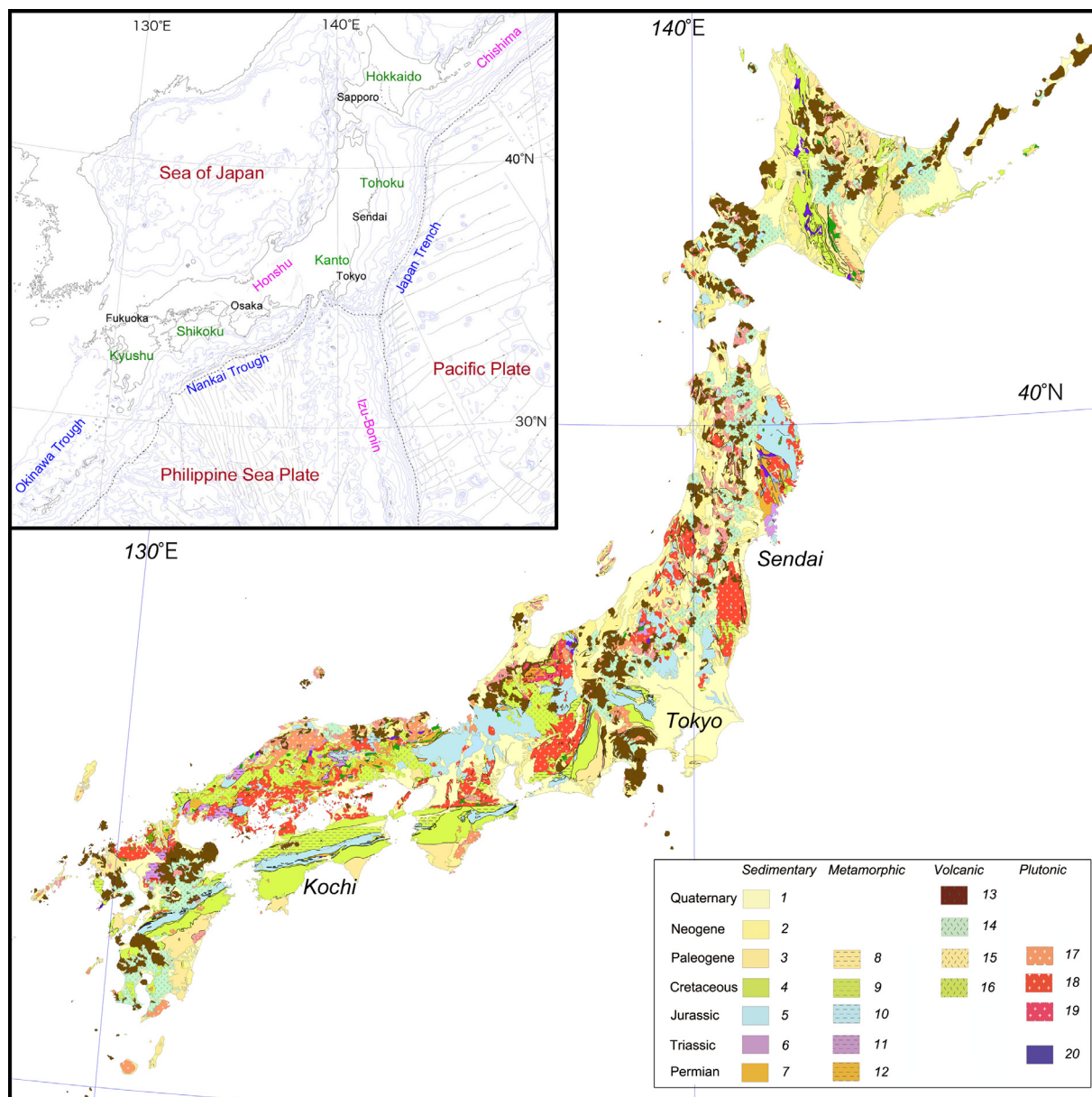


Fig. 1. Geological Map of the Japanese Islands. Japanese part of the International Geological Map of Asia at a scale of 1:5,000,000 (IGMA5000) is based on this geological map data. 1: Quaternary sediments, 2: Neogene sedimentary rocks, 3: Paleogene sedimentary rocks and accretionary complex, 4: Cretaceous sedimentary rocks and accretionary complex, 5: Jurassic sedimentary rocks and accretionary complex, 6: Triassic sedimentary rocks, 7: Permian sedimentary rocks and accretionary complex, 8: Paleogene metamorphic rocks, 9: Cretaceous metamorphic rocks, 10: Jurassic metamorphic rocks, 11: Triassic metamorphic rocks, 12: Permian metamorphic rocks, 13: Quaternary volcanic rocks, 14: Neogene volcanic rocks, 15: Paleogene volcanic rocks, 16: Cretaceous volcanic rocks, 17: Paleogene plutonic rocks, 18: Cretaceous plutonic rocks, 19: Jurassic plutonic rocks, 20: ultramafic rocks.

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