Tectonic Environment of Mesozoic Volcanic Rocks in the Coastal Areas of SE China

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Abstract

Mesozoic volcanic rocks in the coastal areas of SE China consist predominantly of rhyolites and pyroclastic rocks, obviously distinct from island-arc volcanic rocks which consist mainly of andesitic rocks.

Volcanic rocks in these areas mostly belong to the calc-alkaline series, and their geochemical characteristics are dissimilar to those of island-arc rocks. For example, the SiO₂ content varies greatly from 47 to 81 percent, Fe₂O₃ + FeO/MgO > 2, K₂O/Na₂O > 0.8, the contents of Rb, Sr, Ba, Th, U, and Zr are higher than those of island-arc calc-alkaline rocks, and K/Rb < 400.

Andesite in the coastal areas of SE China, for the most part, belongs to the Alkali-calcic series (CaO < Na₂O + K₂O), typical of a continental tectonic environment. Geotectonic studies have shown that the ancient Eurasian continental margin in Mesozoic times was located to the east of the line linking Japan and Taiwan, and the present location of Mesozoic rocks is not an island-arc area. In the light of their characteristically high alkalinity, the Mesozoic volcanic rocks are considered to have been formed in a continental environment rather than in an island-arc environment. Their formation was controlled by a compresso-shear tranform fault system.

Introduction

Mesozoic volcanic rocks are widespread on the eastern margin of China's continent. As advocated by many authors, their formation is related to plate tectonics. Qiu Jiaxiang et al. [11] suggested that the Mesozoic volcanic rocks in eastern China resulted from the subduction of the West Pacific plate underneath the Asian continent, and pointed out that volcanic rocks in the coastal areas (the Wuxi-Shanghai area) are of island-arc type. Li Chunyu [2] and Zhao Mingde and Zhang Peiyao [3] proposed that the Changle-Shao’an fault was a subduction zone during the period from late Paleozoic to early Mesozoic and that the intermediate-acid intrusions and volcanic rocks in Zhejiang, Fujian and Guangdong provinces may represent the products of melting in the front part of the subducting plate. In view of the fact that most of the rocks fall within area B (i.e., orogenic belt and island-arc area) on the GottiNi–Rittmann diagram, Zhang Weiquan et al. (1980) classified the volcanic rocks in the coastal areas of SE China as island-arc type.

In author’s opinion, however, the Mesozoic volcanic rocks in the coastal areas of SE China were formed in a continental environment rather than in an island-arc environment.

Characteristics of Island–Arc Volcanic Rocks

Rock association

Volcanic rocks from modern island arcs (for example, the Aleutians, Kuriles and the
Caribbean island arc, continental margins (Andes) and islands smaller than continents (Japan and Indonesia) share a common feature of being andesitic in composition. Few island arcs are known where equal, or slightly larger, volumes of other volcanic rocks such as picrite–basalt, tholeiite, dacite, etc. also occur, but the number of such exceptions is negligible. Meanwhile, only the youngest arcs are dominated by basalts. The overwhelming majority of old (Mesozoic) or more mature island arcs are composed essentially of andesite. In brief, it can be said that island–arc volcanic rocks are characterized as being dominated by andesitic rocks.

**Rock series**

The volcanic rocks developed in island arcs can be classified into three categories: tholeiitic, calc–alkaline and alkaline (shoshonitic) series. Their temporal and spatial distribution as well as their relative proportions are related to the evolutionary history of island arcs.

It is well known that the island arcs developed on the oceanic crust are usually created at the time the oceanic crust evolves into the continental crust. Development of tholeiitic basalts is expected in the early stage when the crust is rather thin. Then, the tholeiitic series gradually gives way to the calc–alkaline series as the crust becomes increasingly thicker, and alkaline rocks are the most dominant at the final stage. This can be taken as a model for all mature island arcs where an evolution trend of tholeiitic → calc–alkaline → shoshonitic series can be readily recognized in terms of either temporal or stratigraphic sequence.

As viewed from their areal distribution, tholeiites constitute the predominant rock type on the trench side of the island arc (close to the subduction zone) and gradually give way to the calc–alkaline and shoshonitic series with increasing distance from the deep trench.

Generally speaking, a mature island arc consists principally of calc–alkaline rocks. On the other hand, an immature island arc is made up mainly of mafic volcanic rocks—tholeiite of the tholeiitic series and gabbroic rocks of plutonic origin.

**Geochemical characteristics**

A mature island arc is made up principally of calc–alkaline volcanic rocks, which are also the dominant rock type on continental margins. But there exist substantial geochemical differences between the calc–alkaline rocks from the two tectonic environments (Table 1). Island–arc calc–alkaline volcanic rocks contain lower ( < 66%) but relatively constant SiO₂, falling within the range of dacite, and are characterized by higher Mg but lower Fe and K. The contents of trace elements such as Rb, Sr, Ba, Th, U and Zr are low, while K/Rb and Th/U ratios are high (Table 2).

**Characteristics of island–arc andesite**

The island–arc rock series consists mainly of andesite, including some Mg–rich varieties, such as boninite and sanukite, in which the orthopyroxene phenocrysts are extremely Mg–rich with Mg/Fe + Mg ratios being 0.9–0.8 and 0.92–0.8, respectively.

In addition, there is a close relationship between the chemical composition of ande-