Distribution and Geochemical Features of Hercynian–Indosinian Granitoids in Southeastern China

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Abstract

The tectonic patterns of the Hercynian–Indosinian cycle in southeastern China can be divided into two types. The first type is the Hercynian–Indosinian eugeosynclinal system, which is situated on the outer side of the Caledonian uplift belts. The second type is the Hercynian–Indosinian fault depression zone or superimposed basin system, which is developed on the basement formed by the Caledonian orogenic movement. There are two genetically different series of granitoids corresponding to two tectonic settings in the Hercynian–Indosinian tectonic regime of southeastern China.

Among the transformation-series batholiths one of the largest in the Quincou Gulf geosyncline is known as the Darongshan granite (NE-extending) with an outcrop area of about 7000 km². The age of emplacement determined by whole-rock Rb–Sr isochron method ranges from 223 to 263 m.y., corresponding to late Permian, with higher Sr initial ratios (0.7179—0.7274). The granite is chemically rich in K₂O but poor in Na₂O with the atomic Na/K ratio < 1.0 and the mole ratio Al₂O₃/(Na₂O + K₂O + CaO) > 1.0. K-feldspars are usually predominated by medium to maximum microclines with a higher degree of Al–Si ordering characterized by the concentration of Al in T₄ sites of the feldspars (τ₄ (o) = 0.57—0.99). Biotites are often rich in Fe but poor in Mg, belonging to Fe–biotite or siderophyllite, with a lower MF value (Mg/(Mg + Fe³⁺ + Fe²⁺ + Mn)), normally < 0.4, and a lower Fe³⁺/Fe²⁺ ratio of 0.03—0.02 in their octahedron layers. This fact indicates that the oxidation degree of iron is relatively low in the transformation-series granites as compared with the syntexis-series granitoids.

Granitic batholiths of the syntexis series distributed along the fault belts in the Hercynian depressions are usually more mafic, meta–aluminous granodiorites and smaller in size than those of the transformation series, with an outcrop area of 1—200 km². The Taiping granodiorite, for instance, is situated on the southern side of the Lower Yangtze River depression. It was emplaced 223 m.y. ago as dated by whole–rock Rb–Sr isochron method, with an initial Sr ratio of 0.706. Petrochemically, it is characterized by Na/K > 1.0 (1.31), mole Al₂O₃/(Na₂O + K₂O + CaO) < 1.0(0.95) and high Fe₂O₃/(Fe₃O₄ + FeO)(0.47), evidently differing from the transformation–series granites. K-feldspars are predominated by orthoclase with a lower degree of Si–Al ordering (τ₄ (o) = τ₄ (m) = 0.30). Biotites are commonly rich in Mg in their octahedron layers (MF = 0.42—0.50) with higher Fe³⁺/Fe²⁺ ratios (0.36—0.51), indicating their formation under higher oxygen fugacity conditions. All this goes to prove that the syntexis–series granitoids were probably derived from mafic igneous or metamorphic source rocks in the lower crust.

Introduction

In southeastern China are widespread multiple–cyclic granitoids, which have been confirmed to be intimately related to the corresponding multiple–cyclic tectonic movements in space and time. From Proterozoic to Mesozoic, five orogenic cycles have been recognized in this vast region. Among them, the Hercynian–Indosinian cycle is believed to have played an important role in the formation of the present–day continental framework in southeastern China. Having investigated a number of granite bodies, the authors came to realize that the Hercynian–Indosinian granites, like the Yenshanian granites, can be divided into two genetic series in accordance with two different
tectonic regimes. The distinctive features of these two genetic series of granitoids in petrology, petrochemistry, REE distribution pattern and Sr isotopic composition are described in this paper.

**Geological Settings**

As a result of folding, granite intrusion and migmatization processes during the Caledonian orogeny, the major portion of southeastern China was folded and uplifted, giving rise to a number of post–Caledonian uplifts. These uplifts accreted onto the ancient Jiangnan geanticlinal belt. In the remainder of the area, however, was initiated Hercynian–Indosinian tectonism during late Paleozoic. On the basis of the nature of the basement, we can divide it into two tectonic settings. The first is the Hercynian–Indosinian eugeosynclinal system, situated on the outer side of the post–Caledonian uplift belts, including the Qinzhou Gulf geosyncline, the Hainan Island geosyncline and the Zhejiang–Fujian Coast geosyncline. The second is the Hercynian–Indosinian fault–depression zone or the superimposed basin system, including the southwest Fujian–North Guangdong depression, the Hunan–Guangxi–North Guangdong depression, the Pingxiang–Leping depression, the Qiantang River depression, the Lower Yangtze River depression, etc., which are developed on the basement in response to the Caledonian orogenic movement (see Fig. 1).

The Qinzhou Gulf Hercynian–Indosinian geosyncline is located west of the Yunkai post–Caledonian uplift. The late Paleozoic strata are as thick as 5000 m or more, and consist mainly of marine calcite rocks and carbonate rocks. With intensive descending of the geosyncline, marine volcanic eruptions frequently took place from Devonian to Triassic, and volcano–extrusive facies were gradually changed from basic to acidic in composition. The orogenic movement at the end of the Triassic period, called the Dongwu movement, caused re–folding of this region and resulted in the accretion of it onto the neighbourin~ continent. And meanwhile, the huge Dargonshan granite belt exposed over 7000 km² was found intruding into its core part. K–Ar dating of 36 samples gave an age of 213—276 m.y.

In the Hainan Island Hercynian–Indosinian geosyncline, the Shilu Group is a suite of flysch formations with a total thickness of more than 5000 m, which has undergone low–grade regional metamorphism and is intercalated with some metamorphosed marine tholeiitic basalts. Reliable fossil evidence suggests it to be early Carboniferous in age. Late Hercynian movement resulted in strata folding, accompanied with the emplacement of the Zhanxian granite batholith of the transformation series, with an age range of 205—249 m.y. (including K–Ar and Rb–Sr methods).

The Zhejiang–Fujian Coast Hercynian–Indosinian geosyncline lies east of the Zhenghe–Dapu deep fault. This area is extensively covered by Mesozoic volcanic rocks. However, an 8–km² isolated outcrop (like a “window”) of Hercynian basement rocks has been found near Shixi Village, Fuding County, Fujian Province. It consists of thick geosynclinal flysch formations with siliceous intercalations, totaling up to several thousands of meters in thickness (the bottom is not exposed), and contains actually middle Carboniferous fossils. This tectonic regime may extend northwestward through the East China Sea into Japan. The unconformity between the early Jurassic and late Triassic strata provides strong evidence for the Indosinian movement in this region, which led to the emplacement of Indosinian g·anites such as the Guiyang gneissic granite with a K–Ar age of 210 m.y. The transitional relationship between the granite and its adjacent late Carboniferous mica–chlorite schists indicates that it was the product of syntectonic migmatization.