Chemistry of Volcanic Rocks and Seismicity of the Earth's Mantle in the Island Arcs *

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Abstract

Volcanic belts in island arcs are associated in space with epicenter belts of mantle earthquakes. Primary magma of volcanoes on the oceanic side of an island arc is rich in silica and poor in alkalies. In contrast, it is poor in silica and rich in alkalies on the continental side. Foci of the mantle earthquakes are close to a plane that dips away from the oceanic side toward the continental side. The spatial correlation between nature of primary magmas and depth of earthquake foci suggests a common origin.

Moreover, the hypothesis that the generation of magma and the occurrence of mantle earthquakes are genetically related and that the primary magmas in the island arcs are generated at levels about 150 to 250 km deep, is supported by the relationship among different island arcs, that is, primary magma of volcanoes fronting on oceanic trenches becomes more silicious from one arc to another as the seismicity of mantle earthquake zones becomes greater.

Introduction

Increase of interest in the study of island arcs has been marked during the past 20 years. All the island arcs lie along an active belt that surrounds the Pacific Ocean. The island arcs are associated with a number of crust-mantle features which occur in a series of arcs arranged in parallel zones and include mantle earthquake zones and volcanic belts. The association of epicenter belt of mantle earthquakes with volcanic belt suggests a common origin. However, at the present stage of the study the genetic relation is still uncertain.

The same author of this paper describes the problem of this

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genetic relation more extensively in a chapter in a symposium volume on rocks of basaltic composition (SUGIMURA, in press). The chapter deals with the geographical and chemical variation of rocks of basaltic composition in relation to geotectonics and geophysics. The main purpose of this paper is to provide additional data for consideration of the nature of the genetic relation. Therefore, we first consider the energy source of magma generation, and then an interrelation between the chemical characteristics of primary magmas and the seismicity of the earth's mantle to test the idea.

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**Previous Work and Definitions**

*Island arc.*

In this paper *island arc* is used for both island arcs and mountain arcs along continental margins with the following three features:

1) Recent volcanic activity,

2) Oceanic trenches deeper than 6,000 meters after FISHER & HESS (1963, p. 418-419), and

3) Earthquake foci at depth greater than 70 km after GUTENBERG & RICHTER (1954).

The island arcs are grouped into the following twelve regions, according to the geographic zoning adopted in the «*Catalogue of the Active Volcanoes of the World, Including Solfatara Fields*» (NEUMANN VAN PADANG, 1950, p.x): 1. New Zealand to Tonga, 2. Melanesia, 3. Indonesia, 4. Philippines, 5. Taiwan and West Japan, 6. Marianas and East Japan, 7. Kuriles and Kamchatka, 8. Aleutians and Alaska, 9. Central America, 10. West Indies, 11. South America, and 12. Antarctica (Fig. 1). (The zoning in the *Catalogue* differs from the above one only in two points, that is, 5. and 6. are combined to one and 7. is divided into two.)