Chapter 2 Volcanoes, Volcanic Rocks and Magma Chambers

Volcanoes are hills, mounds or sheets of relatively localized igneous rock assemblages made up of pyroclastic rocks, lava flows, and intrusions in varying proportions. Volcanoes differ notably in their geometry, volume, and relative amounts of pyroclastic rocks and lava flows, with differences mostly dependent upon eruptive mechanisms and rates of extrusion. These in turn depend chiefly upon the magma composition. Chemical composition of magma is also responsible for, or can be correlated with, physical properties such as volatiles and viscosity, which govern to a large extent the nature of many pyroclastic eruptions.

In a broad way, magma types can be divided into mafic, intermediate and silicic varieties, magma being defined as melt $\pm$ crystals $\pm$ gas (dissolved or in bubbles). The dominant and most widespread supply of pyroclasts on land is from the intermediate and highly silicic/alkalic magmas.

Among the major new aspects in the study of pyroclastic rocks is the increasing recognition that these rocks harbor a wealth of petrologic information about their parent magmas. Foremost in this respect is the fundamental observation that many magma chambers are mineralogically and chemically zoned, and a topic of much current interest centers on the nature of processes that lead to such zonations.

Tectonic Setting of Volcanoes

Most active and dormant volcanoes occur in belts that coincide with zones of earthquakes. The main volcanic and seismic belts define boundaries of large lithospheric plates. Lithospheric plates which range in thickness from less than 30 to 200 km are believed to move over the asthenosphere along a layer of lower density that may contain a small amount of magma. Major types of plate margins are: (1) divergent or constructive, (2) convergent or destructive, and (3) margins that slide laterally past one another (Figs. 2-1, 2-2). Of the active subaerial volcanoes associated with plate boundaries, about 80 percent occur within convergent and 15 percent in divergent settings (Fig. 2-1). About 5 percent occur away from plate margins in intraplate settings. Magmas generated along sites of divergence – mid-ocean rifts and rises and marginal basins – and within oceanic and continental plates are dominantly mafic; more silicic magmas are generated chiefly near or above sites of subduction (convergence) in regions of island arcs and active continental margins, or else within continental and, more rarely, oceanic plates.

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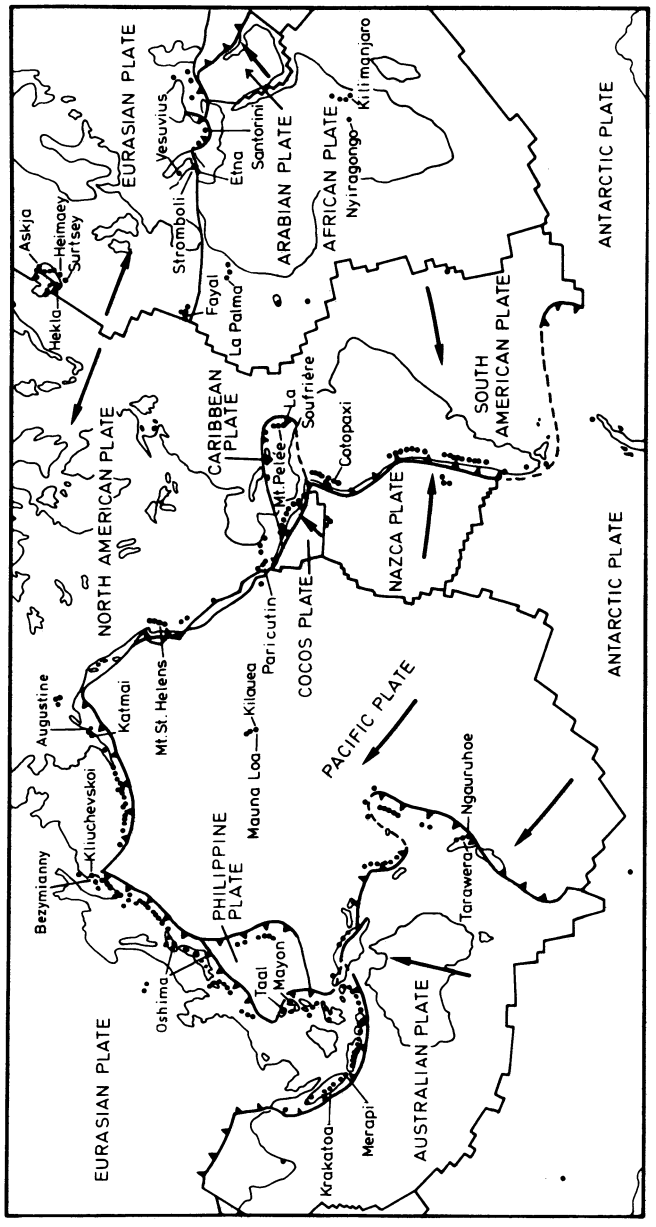

Fig. 2-1. Major plates, mid-ocean ridges and subduction zones. Names of active volcanoes shown are those mentioned in text. (After Macdonald, 1972; Press and Siever 1978; Simkin et al., 1981)

Divergent Margins

Divergent margins are sites of extension where oceanic lithospheric plates are generated and move away from one another. Important divergent plate margins are the present-day mid-oceanic rises and ridges such as the Mid-Atlantic Ridge, the East Pacific Rise and the Carlsberg Ridge in the Indian Ocean. They are charac-