Contrib Mineral Petrol (1992) 110:500–514

Contributions to Mineralogy and Petrology
© Springer-Verlag 1992

Geochemistry of mafic dikes in the Adirondack mountains: implications for late Proterozoic continental rifting

R.A. Coish and C.W. Sinton*

Geology Department, Middlebury College, Middlebury, VT 05753, USA

Received January 16, 1991 / Accepted June 7, 1991

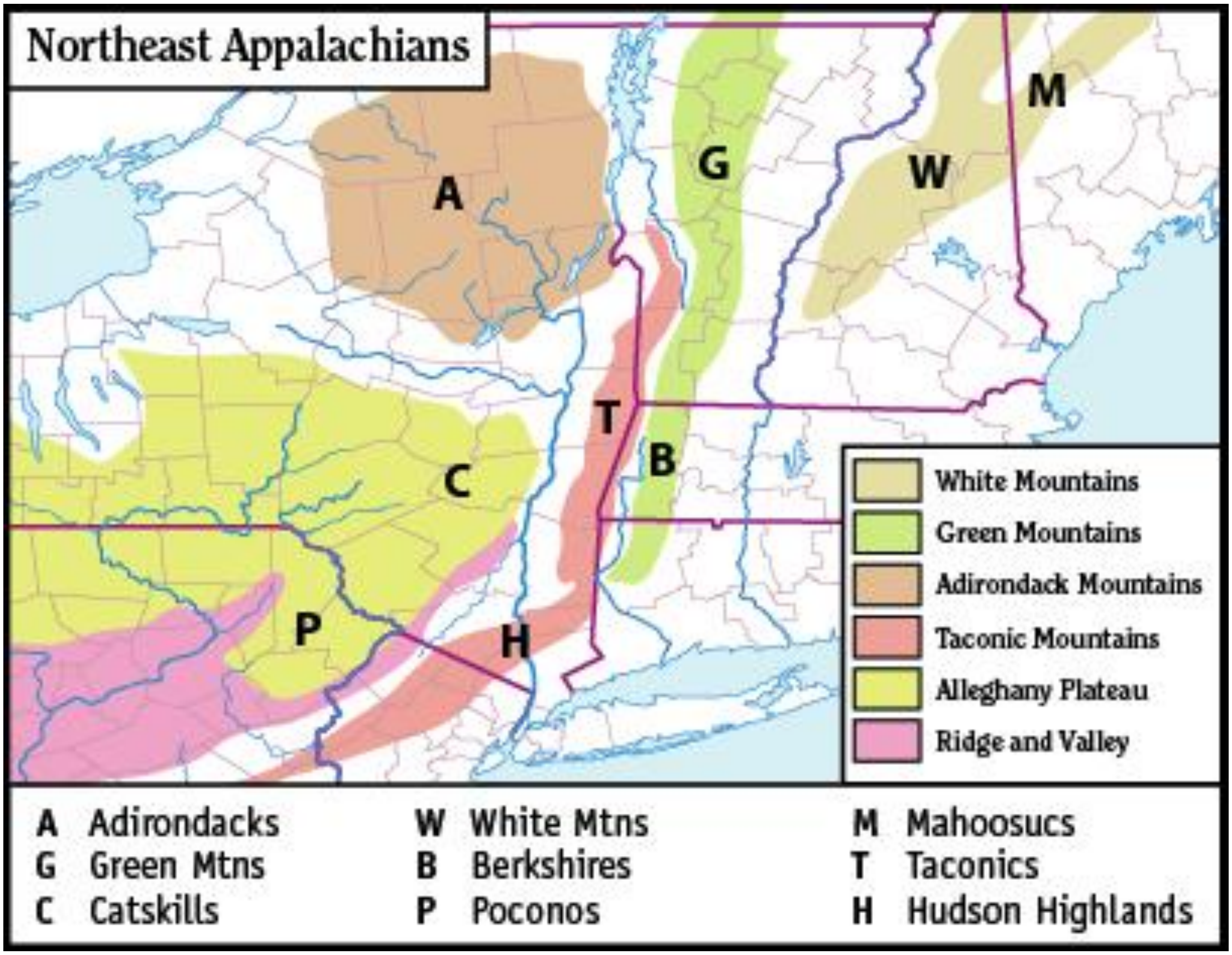
Abstract. Mafic dikes of late Proterozoic age which cut Grenvillian crust in the northeastern Adirondack Mountains are mostly mildly alkaline basalts except for a few tholeiitic examples. All dikes are high in Ti, P, K, Zr, Y, and LREE, and plot in within-plate fields on tectonic discriminant diagrams. The dikes are similar in composition to Hudson Highland dikes in southern New York and New Jersey and to the Bakersville dike swarm in the southern Appalachians. They differ from the Grenville dike swarm in Ontario and Quebec in being alkaline and having higher Ti and P contents. Mesozoic alkaline dikes in the same geographic area as the Proterozoic ones are strongly enriched in Ba, K, Rb and LREE, and approach lamprophyre in composition. The Proterozoic dikes have low La/Nb and La/Ta ratios, suggesting that subduction-modified mantle lithosphere was not substantially involved in their genesis. This contrasts with certain Mesozoic tholeiitic dikes, associated with the opening of the Atlantic, which show sharp negative Nb or Ta anomalies relative to La indicating they were derived from subduction-modified lithospheric mantle. The trace element chemistry suggests that the source for the Proterozoic dikes was trace element-enriched asthenosphere (OIB-like source), as postulated for certain basalts erupted in the East African Rift system, and in parts of the Basin and Range Province of the southwestern United States of America. Finally, the Proterozoic dikes are chemically similar to rift volcanics from the western Vermont Appalachians, and thus they are thought to represent magmatism associated with extension of the Grenvillian crust prior to opening of the Iapetus ocean.

Introduction

The study of volcanism before and during continental rifting is extremely important in understanding two geological and geochemical problems: the nature of continental breakup and the composition of sub-continental lithosphere and asthenosphere. Most recent studies have dealt with Mesozoic rifting of the Pangea supercontinent, Cenozoic rifting in the Basin and Range Province of the western United States, and modern-day rifting of the east African continent (Altherr et al. 1990; Barrat et al. 1990; Coleman and McGuire 1988; Fitton et al. 1988; Fodor and Vetter 1984; Hart et al. 1989; Hawkesworth et al. 1988; Hawkesworth et al. 1990; Leat et al. 1988; Leeman and Fitton 1989; Mallick et al. 1990; Martinez and Cochran 1988; Pegram 1990; Petrini et al. 1988; White and McKenzie 1989). There have been a few studies on volcanism associated with the late Proterozoic rifting of the North American continent (Coish 1989; Coish et al. 1985; Coish et al. 1986; Francis et al. 1983; Goldberg et al. 1986; Ratcliffe 1987; Strong et al. 1978). The geochemical studies on Mesozoic and modern recent rift volcanics have focussed on whether rifting is active or passive, and what is the nature of the source materials melting during various stages of rifting. Regarding the latter point, it is thought that volcanics erupted through either thick or thin continental crust have four potential source materials: the deep primitive asthenosphere, the shallow depleted asthenosphere, the enriched mantle lithosphere, and the continental crust (e.g. Fitton et al. 1988; Leeman and Fitton 1989). Although the continental crust will not yield basalt upon melting, it can influence the chemistry of basalts by contamination as basaltic magma ascends (Hawkesworth and Vollmer 1979; Leat et al. 1988; Piccirolo et al. 1989; Hawkesworth et al. 1990). The importance of sub-continental lithosphere versus asthenosphere as a source for rift and continental basalts is currently being debated primarily on the basis of key trace elements and isotopes in continental basalts (Fitton et al. 1988; Leat et al. 1988). Moreover, within the asthenosphere, what is the role of the depleted mantle, the source of mid-ocean ridge basalt (MORB) versus the role of more enriched mantle, the source of ocean island basalts (OIB)?

The purpose of this paper is to describe the petrology and chemistry of late Proterozoic metadiabasic dikes intruding the 1000 Ma Adirondack massif, and to use the

* Now at College of Oceanography, Oregon State University, Corvallis, OR 97331, USA
Offprint requests to: R.A. Coish



Extent (orange regions) of the Grenville orogeny is related to the Grenvillian crust refered to in the paper above.

There are many new applications for rare earth elements in modern vehicle engineering

Many of the rare earth elements (REEs) and high-value metals known to exist in Adirondack deposits are used in the ten vehicle functional components exhibited below. Other vehicle features use the metals titanium and scandium [while not explicitly named in the paper, since scandium and yttrium are in the same IIIB-group of the Periodic Table, they are likely to occur in the same locale (e.g., titanium and zirconium are in the same IVB-group, and they occur together in some of the Adirondack deposits)]. Scandium is used as an alloying agent in the light-weight aluminum-scandium alloy, scandium iodide in High Intensity Discharge (HID) vehicle headlamps and in some catalytic converter designs.