[AMERICAN JOURNAL OF SCIENCE, VOL. 284, APRIL/MAY, 1984, P. 290-293]

MAFIC AND ULTRAMAFIC ROCKS OF THE APPALACHIAN OROGEN — AN INTRODUCTION

KULA C. MISRA and HARRY Y. McSWEEN, JR.
Department of Geological Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410

The current interest in Appalachian mafic-ultramafic rocks stems largely from their potential for providing constraints for interpretation of the magmatic, metamorphic, and tectonic evolution of the Appalachian orogen. The geologic information contained in mafic-ultramafic rocks is not always easy to retrieve, but recent advances in geochemical and isotopic techniques offer promise in solving this difficult problem. Application of such techniques is a recurrent theme of the papers in this issue. Of course, such techniques are not substitutes for field and petrologic data which still constitute the foundation for studies of mafic and ultramafic rocks. Papers in this issue illustrate the desirability of such multi-directional approaches to the understanding of Appalachian mafic-ultramafic rocks.

The mafic-ultramafic rocks of the Appalachian orogen constitute a very heterogeneous group in terms of their distribution, stratigraphic position, form and size, and, as is becoming increasingly evident, tectonic setting. They are distributed over the entire length of the orogen, from Newfoundland to Alabama, and they occur associated with rocks that range in age from late Precambrian to Paleozoic. They include ophiolites in various degrees of preservation; ultramafic pods with or without associated amphibolite; metabasaltic complexes; mafic dikes, sills, flows, and pyroclastic units as components of metasedimentary sequences; and gabbroic-metagabbroic plutons, occasionally with ultramafic differentiates. Obviously, it is not possible to include even representative examples of each category in this limited collection of papers. Some of the contributions selected for this issue offer regional perspectives, and others deal with specific areas or complexes (fig. 1); all of them provide some new insight into the relationships of mafic and ultramafic rocks to the early evolution of the Appalachian orogen. Late Paleozoic kimberlites and Mesozoic diabases have been excluded from consideration here.

This special issue begins with a review of the distribution and characteristics of southern Appalachian mafic rocks by Misra and McSween. They conclude that the late Precambrian (-early Cambrian) mafic rocks of the Blue Ridge and Inner Piedmont were formed predominantly in a continental rift environment, in contrast to a largely convergent plate-tectonic setting for the early to middle Paleozoic volcanism in the Piedmont and Talladega belts. The diverse tectonic settings of Appalachian mafic-ultramafic rocks are further emphasized in the paper by Shaw and Wasserburg, who use Nd–Sr isotopic signatures to distinguish pieces of proto-Atlantic oceanic crust from continental intrusives. This paper provides some surprises for those interested in Appalachian ophiolites.

The next three papers concentrate on specific suites of mafic volcanics (and associated rocks) from three widely separated areas in the Appa-

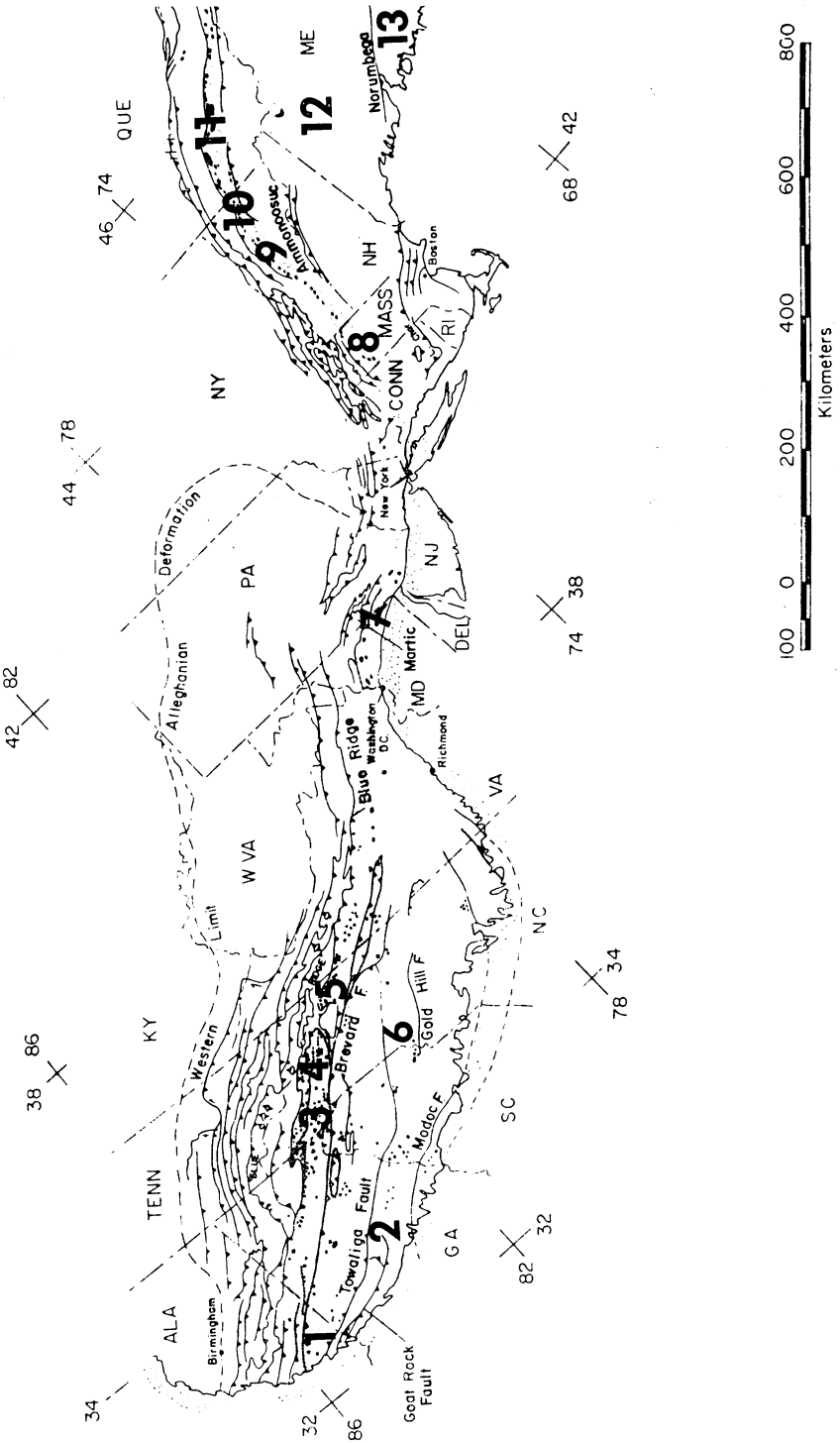
lachians, but with different emphasis. Abbott and Raymond propose an ensimatic model for the Ashe Formation of North Carolina, using metamorphism of its mafic-ultramafic rocks as a key line of evidence. Laird, Lanphere, and Albee present maps for Ordovician and Devonian metamorphism in north-central Vermont. Combining petrology with K-Ar data, they show that mafic and pelitic schists in this region were subjected to medium- to high-P metamorphism (Taconic subduction event) and an overprint of medium-P metamorphism (Acadian collision event). From a comprehensive geochemical study, Stow, Neilson, and Neathery conclude that amphibolites of the Alabama Piedmont represent metamorphosed tholeiitic basalts, the parental magmas of which were generated in oceanic rift or island arc environments.

Two papers deal with gabbroic intrusions in different parts of the orogen. The paper by McSween, Sando, Clark, Clark, Harden, and Strange summarizes recent research on the chain of gabbro-metagabbro complexes in the Carolina Piedmont. They suggest that the Paleozoic complexes were emplaced at a convergent plate boundary, the gabbros possibly utilizing the pathways established by the earlier metagabbros. Thompson proposes a very different origin for the syn-Acadian gabbroic intrusions of Maine: their emplacement was controlled by tension in the crust during waning stages of the Acadian orogeny.

The last four papers illustrate diverse views on the origin of Appalachian ultramafic rocks. Hatcher, Hooper, Petty, and Willis discuss three southern Appalachian bodies of different tectonic settings: the Laurel Creek complex as a possible ophiolite, the Carroll Knob complex as an ophiolite or a complex pluton, and the Gladesville complex as a part of a mafic arc complex. Using compositional and textural variations of the associated chromites, Lipin argues that Blue Ridge dunites are metamorphic and not primary mantle peridotite. A petrologic study of metamorphosed ultramafic lenses in the Bronson Hill anticlinorium of Massachusetts is presented by Tracy, Robinson, and Wolff, who propose that the ultramafic lenses represent picritic lava flows rather than dismembered ophiolites. In contrast, from detailed field relationships and structure, Stanley, Roy, Hatch, and Knapp interpret the ultramafic rocks and associated basalts of western New England as fragments of oceanic crust.

It is unlikely that all the opinions expressed in the various papers will find universal acceptance, but we hope that they provide a stimulating sample of current thoughts on the mafic-ultramafic rocks of the Appalachian orogen and an incentive for additional research.

We wish to acknowledge John Rodgers for his enthusiastic response to our proposal for this special issue, the editorial staff of the American Journal of Science for continued cooperation, and the authors and the reviewers who participated in this effort. We also appreciate the support of our colleagues and staff of the Department of Geological Sciences, University of Tennessee.


QUE
ME
NH
MASS
CONN
RI
NY
PA
NJ
DEL
MD
VA
WV
KY
TENN
NC
SC
GA
ALA
Deformation
Allegh anian
Limit
Western
Blue Ridge
Brevard F
Gold Hill F
Modoc F
Towaliga Fault
Goat Rock Fault
Birmingham
Washington DC
Richmond
Boston
New York
Amonoosuc
Norumbega
Martic
1
2
3
4
5
6
7
8
9
10
11
12
13
34
32
86
38
82
42
78
44
74
46
68
42
74
38
78
34
82
32
86
100 0 200 400 600 800
Kilometers

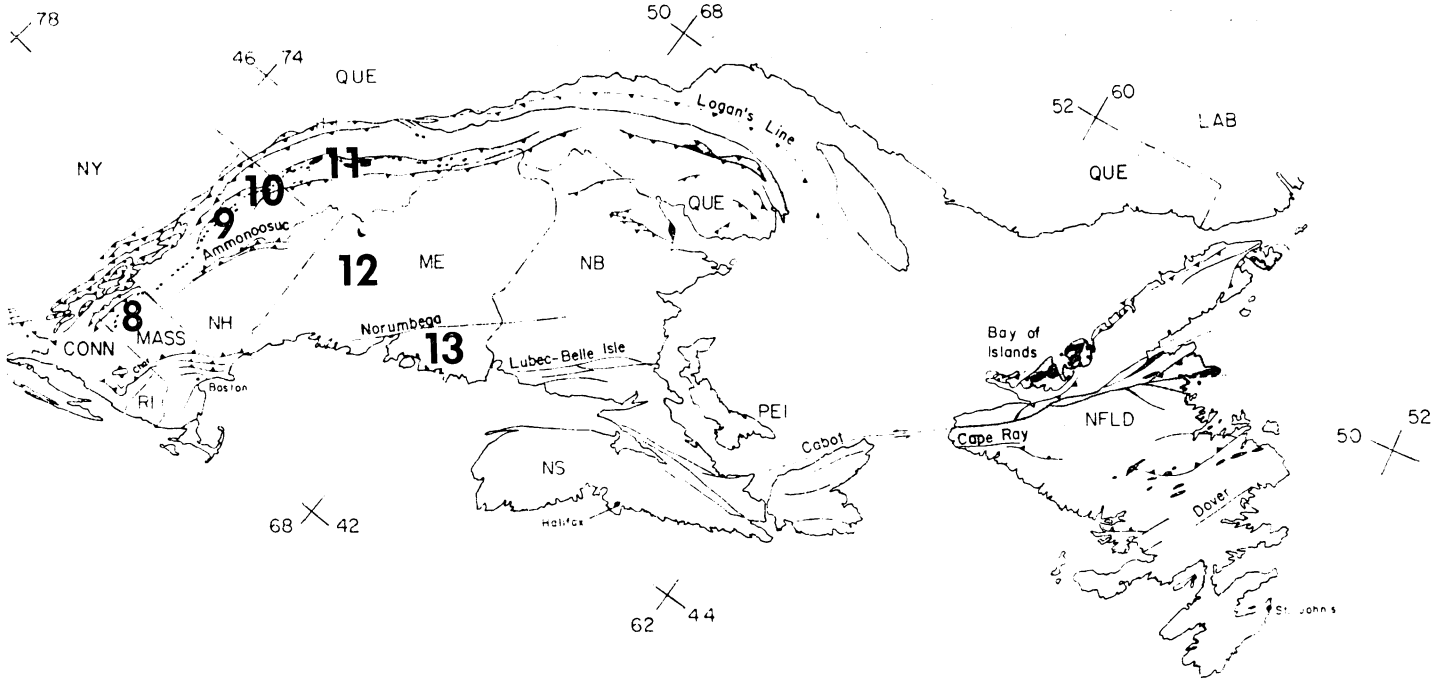


Fig. 1. Map of the Appalachian orogenic belt showing the major structures and the locations of areas discussed in the various articles included in this issue: (1) amphibolites of the Ashland Sequence in Alabama; (2) Gladesville gabbroic complex of the Georgia Piedmont; (3) Lake Chatuge, Chunky Gal, Carroll Knob, and Laurel Creek mafic-ultramafic complexes of the North Carolina-Georgia Blue Ridge; (4) Blue Ridge ultramafic belt in North Carolina; (5) Ashe metavolcanic-ultramafic complex of North Carolina; (6) Gabbro-metagabbro complexes of the Carolina Piedmont; (7) Baltimore mafic complex of Maryland; (8) Ultramafic rocks of the Bronson Hill Anticlinorium in Massachusetts; (9) Mafic schists of northern Vermont; (10) Serpentinized ultramafic belt of Vermont; (11) Thetford Mines complex of Quebec; (12) Central Maine gabbroic plutons; (13) Coastal Maine gabbroic plutons. The shaded area is the principal western mafic-ultramafic belt of the Appalachians. Black dots represent ultramafic bodies. The geologic map was provided by R. D. Hatcher, Jr. and drafted by Teunis Heyn.