The perception that orogens may be divided into eugeosynclines having abundant volcanic rocks and miogeosynclines lacking volcanics triggered the hypothesis that eugeosynclines are perhaps ancient island arcs. Subsequent geophysical and geological studies supported a concept of eugeosynclines as at least partly comprising ancient oceanic terranes as well as arcs. It has become increasingly evident that to understand the role of orogenesis in crustal evolution the extent of oceanic crust in the basement of eugeosynclinal belts must be determined.

A consistent feature of eugeosynclines is their composite nature as manifest in elongate tectono-stratigraphic units or tectonic elements. The stratigraphic, tectonic, and plutonic and metamorphic evolution of each element is distinct and yet is partly related to adjacent elements. Major tectonic elements are separated by long-lived faults. The lithological sequence of each element is correlated with its basement type and the nature and history of its boundaries. Ancient eugeosynclinal tectonic elements may be elucidated by comparison with modern tectonic elements clearly related to plate motions. The basement of such tectonic elements is highly varied, and thus all eugeosynclinal zones are not ensimatic.

Tectonic processes play a key role in determining preservation and mode of occurrence of oceanic lithosphere in orogens. To survive orogenesis, oceanic crust must have a thick low-density cap or be tectonically intercalated with thick lower density materials. Preservation of oceanic crust and mantle within orogens therefore requires some mechanism of crustal thickening, commonly by sedimentation (to form buried basement of sedimentary turbrocks), magmatism (to form basement of oceanic arcs), or tectonic imbrication (to form ophiolite sequences and mélangé belts). In the absence of such mechanisms, gravity and subduction can efficiently remove dense oceanic lithosphere from the crust. The crust of continental rifts, rhombochasmatic, sphenochasmatic, marginal basins, oceanic arcs, and remnant basins is susceptible to the crust-thickening mechanisms mentioned above and is, therefore, more abundantly preserved in orogenic belts than is normal ridge-generated oceanic crust.

The diagnosis of ensimatic tectonic elements within ancient orogens is difficult, but the composition of igneous rocks and other data can be related to basement composition. The composition of detritus can also indicate the nature and time of linkage of source blocks. The sialic vs. simatic nature and extent of the initial basement of eugeosynclinal zones are highly varied and are dependent upon the evolution of the individual orogen in terms of geometry and nature of starting conditions, rifts, arcs, marginal and remnant basins, subduction zones, and strain history. The addition of oceanic and mantle materials to the continents by orogen accretion is complex due to the interaction and evolution of many processes. Single processes may be described but not single theories or finite models of orogenesis. Each orogen is a unique time-space collage of mappable elements, all generated, assembled, and rearranged by tectonic processes.

INTRODUCTION

The most interesting scientific questions invariably seem to deal with that which is just beyond our powers of observation. Such is true with the deep structure of orogenic belts, in particular the question of the nature and origin of the basement of eugeosynclinal belts. This question is fundamental to our understanding of orogenesis and crustal growth.

Eugeosynclinal belts have been identified as the sites of continental accretion, either because they rarely have any presumed basement exposed, or because the oldest exposed rocks are ophiolites or greenstones. If eugeosynclinal belts develop on preexisting sialic crust (ensialic), continental growth is dominantly vertical; this would be true if orogens are essentially tectonized continental shelf-slope-rise complexes. If eugeosynclinal belts are ensimatic, forming beyond continental margins on oceanic crust, then the continents have expanded laterally at the expense of ocean basins by accretion of eugeosynclines (Stille, 1941; Wells, 1949; Wilson, 1949; Kay, 1951; Drake and others, 1959; Dietz, 1963). According to plate tectonic concepts, both types of continental growth occur, although the problem remains to distinguish the tectonic elements, igneous rocks, and sediments of orogens that represent oceanic crust or upper mantle contributions (Dewey, 1969).

Stille (1941), Kay (1944), Wilson (1949), and Hess (1962) fully realized that a most important component of the eugeosyncline is the island arc. Few geologists realized the significance of this comparison or the need for rigorous study of island arcs. The great strides of marine geology, seismology, and volcanic geochemistry over the past decade have led to the