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Ranges beside the San Andreas fault. Where the plates are converging, the geometry requires that one overlap the other in some fashion, hence that some crustal rocks which approach the region of collision either disappear from the surface or undergo some drastic lateral crumpling. The plate tectonic model clearly implies that the mechanical energy available to drive orogenic processes, either directly to deform rocks or indirectly by conversion to heat, is greatest along convergent junctures. As Dewey (Cambridge) has shown, the empirical evidence also favors this view.

In strictly kinematic descriptions of relative plate motions, convergent plate junctures can be called sinks with reference to the fact that the areal dimensions of one or both adjacent surficial plates are reduced somehow as lithosphere is, in effect, consumed by overlapping or crumpling of plates, removed by descent into the deeper mantle, or otherwise destroyed as a surficial entity in some unspecified fashion. The dominant real process is thought to be the descent of lithosphere, with a capping of thin oceanic crust, in the vicinity of intraoceanic trenches and trenches marginal to continents. The course of descent is thought to be marked by the inclined seismic zones that reach deep into the mantle beneath the intraoceanic island arcs, like Tonga and the Marianas, and the marginal continental ranges, like the Andes, where chains of explosive volcanoes stand parallel to nearby trenches. In some exceptional cases, however, lithosphere with a capping of thick continental crust may serve as the descending plate of a converging pair, as in the Himalayan region where at least part of the continental crust of the Indian plate appears to have passed beneath at least part of the Tibetan plate.

The complexity of the telescoping and overlapping of crustal rocks observed along ancient convergent plate junctures became evident from discussions at the conference. Most participants, therefore, adopted a general term, "subduction zone," to describe any linear region along which crustal rocks have been led to descend relative to an adjacent block by folding or faulting or both in combination. The term was coined by Alpine geologists, and recently revived, in its English translation, by the Esso (Houston) research group as a term appropriate for a process of broad crustal significance; the term was introduced to the con-

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movements in the opposite sense. Oriel (U.S. Geological Survey) analyzed the geometry and timing of the late Mesozoic and early Tertiary Idaho-Wyoming thrust belt and found them consistent with those of Canadian counterparts but inconsistent with proposed gravitational models. The geometric relation of the thrust belt to the roughly coeval Sierra Nevada, as reconstructed by Hamilton and Myers, resembles that suggested by Hamilton for the late Cenozoic thrust belt in the eastern foothills of the modern Andean volcanic arc. Burchfiel (Rice) and Davis (University of Southern California) showed how opposed thrust systems of this type can form the major structural elements of a two-sided orogen, with a trench on one side and an inland thrust belt on the other.

An important impression that emerged from the proceedings was the realization that the nomenclature of tectonic elements and stratigraphic facies in orogenic belts requires revision and further evolution. The meaning of the geosynclinal theory, which holds roughly that thick sedimentation in a linear belt precedes and predestines orogeny, must be translated into a new conceptual framework. Past usage has relied heavily on the concepts of eugeosynclinal and miogeosynclinal sequences, supposedly deposited side by side in a single large trough or in complex parallel furrows, as the forerunners of orogenic belts. Eugeosynclinal assemblages are commonly conceived to be rich in volcanic rocks and deep-water turbidites, and to underlie early, protracted, and intense deformation capped by metamorphism and plutonic intrusion. Miogeosynclinal sequences, by contrast, lack volcanic rocks and undergo less deformation of a more surficial kind. At least three kinds of assemblages can now be identified with reference to modern analogs which can be related to current plate geometry.

One kind of eugeosynclinal sequence, that like the Franciscan assemblage of California, can be called a trench complex, and recognized as pervasively sheared, graywacke-bearing melanges in which terrigenous detrital turbidites are mingled depositionally and tectonically with offshore sea-floor strata including pillow lavas of the oceanic crust. Such sequences are not built in ordinary stratigraphic superposition, but are stacked tectonically over a period of time as materials are successively ridden into a trench and under its inner wall. The

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pervasive shearing and stratigraphic discontinuity within melanges have been described at length by Hsu (Zurich), who led a preconference field trip to exposures along the coast near the conference site.

A second kind of eugeosynclinal sequence, perhaps the most familiar type, can be called an arc complex, and recognized as largely andesitic and dacitic volcaniclastic strata intruded by partly cogenetic granitic plutons. Such sequences are not accumulated in a topographic trough, but pile eventually to great thicknesses through progressive subsidence as described by Markhinin in the Kurile Islands. Facies range from shallow marine and even subaerial near volcanic centers to deep marine in blocky basins between volcanoes. A third kind of sequence locally called eugeosynclinal is composed of sea-floor lutites and distal turbidites deposited on basaltic crust in deep water beyond the continental slope of stable continental margins.

One kind of miogeosynclinal sequence, the miogeocline of Dietz, can be called a continental terrace complex, and represents the sediment built mainly in shallow water off the edge of a stable continental margin. Such sediment wedges may differ little in facies from platform deposits, but can reach great thicknesses, especially where they are built across the foundering edge of a continent. Rifting associated with the opening of a new ocean causes thinning of the crust where it necks and divides.

A second kind of miogeosynclinal sequence, that like the Great Valley sequence of California, accumulates as detritus eroded mainly from an adjacent and parallel magmatic arc, and deposited in an elongate sediment trap between arc and trench. The site of deposition can be a shelf, slope, or trough in this tectonic position, separated from the trench by a bathymetric basement ridge of the type that Karig (Scripps) especially has noted at the top of the inner walls of trenches as a characteristic tectonic element in many modern arc-trench systems. A third kind of sequence, called miogeosynclinal by some and exogeosynclinal by Kay, is the elastic wedge foredeep complex, with the Cretaceous of the continental interior and the Devonian of the northern Appalachians as examples. Such sequences are deposited in variable water depths in troughs apparently associated with secondary subduction zones.

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comes of the idea that geosynclinal deposition presages the eventual onset of orogenesis and controls its effective extent? In the cases of the first two kinds of eugeosynclinal sequences and the last two kinds of miogeosynclinal sequences, sedimentation is simply a part of an unfolding process in which some deformation of the strata accumulated is an inexorable sequel. Even so, each case is somewhat different. In the case of the continental terrace, or miogeoclone, and its offshore facies equivalents on continental rise or abyssal plain, there appears to be no immediate proclivity for deformation of the strata, as the continental margin is stable. In this case, the time dimension of plate tectonics comes into play. Oceans can be shown to have opened and closed. Once isolated continents come to be sutured together by collisions at subduction zones along which intervening oceanic crust is consumed. Hence, given time, any stable continental margin will eventually encounter a subduction zone at a convergent plate juncture, and will ride either over it or into it. In either case, the flanking sediment wedge will be deformed in some fashion; for a thick sedimentary pile simply to exist at a continental margin thus predestines eventual deformation when, inevitably, the margin becomes active.

In a sense, then, the geosynclinal theory of orogeny remains valid if the causative function of a thick sediment prism is replaced by a notion of coincidence or consequence. In another sense, the theory is perhaps more faulty and potentially misleading. A single, sequential orogenic progression is commonly assumed to be the norm. This notion cannot be expected to remain part of the plate tectonic model of orogeny. As oceans open or close and continents rift or join, as arcs and trenches and thrust belts grow and die with migrations and possible reversals of polarity, as one type of tectonic element is superimposed upon or juxtaposed against another, we have no reason to suppose as yet that there is any unique order in which these events may occur in a given region or happen to a given rock mass. Hence, different orogenic belts may undergo different sequences of deformational events. Each step ought to be one of a finite array of types, but the order of the steps should vary from place to place.

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