and *Sphaeroidinella dehiscens* defines the very late Pliocene and early Pleistocene. Onset of climatic deterioration in both regions defines the base of the Pleistocene. In Italy the base of the Pleistocene corresponds to the arrival of the cold-water immigrant species *Arctica islandica* and *Hyalinea balthica,* whereas in the Caribbean and Gulf of Mexico climatic cooling was accompanied by either extinction or withdrawal of the warm-water Pliocene species *Globoquadrina altispira, G. venezuelana,* and *Globorotalia menardii* and the appearance of the cool-water immigrant species *G. inflata.* Paleobathymetric and physical evidence shows upward shallowing of facies in the very late Pliocene and early Pleistocene, which seemingly is indicative of and related to glacio-eustatic phenomena

DISTINGUISHED LECTURE TOUR ABSTRACTS, 1968–1969

RAMON E. BISQUE, Colorado School of Mines, Golden, Colorado

Explosion in Geological Education and Its Future Effects on the Profession

This fall (1968) several hundred thousand high school students across the nation are studying their environment through a series of laboratory and field investigations. These investigations are designed to permit the students to discover principles of science for themselves and understand earth processes. Stream tables, rock and soil samples, fossil models, field trips, and stereoscopes are now commonplace in thousands of high schools.

The earth and space orientation of this new science course will influence the perspective of millions of youngsters during the next few years. Geoscientists and their efforts will be viewed within the framework of science and the geodisciplines will benefit from an understanding and appreciation in the younger generation that they have never before experienced.

Geology in particular stands to benefit from the new surge of interest that these youngsters will carry with them. A widespread realization of the essential and basic contribution of geology to the progress of mankind is but a part of the dividend. New areas of research will be opened and advanced as greater numbers of young scientists, teachers, and technicians apply their intellect to the study of our planet.

Geologists in our universities and industries should be aware of this new facet of secondary school science education and be prepared to reap the benefits for the geologic profession.

ROBERT F. DILL, U. S. Navy Electronics Laboratory, San Diego, California

Pleistocene Sea Levels and Continental Margin Sedimentation

Continental margin sedimentation has been controlled greatly by large fluctuations of Pleistocene sea level and differential channeling of sediment down submarine canyons. Relatively recent stillstands of the strandline have cut terraces and sea cliffs into the continental slope to 700 ft below present sea level. Shallow-water fossils of late Pleistocene age have been collected from these terraces during deep-submersible dives with the *Deepstar.* During the lowered stand most submarine canyons actively diverted shallow-water sediments into the deep sea and marginal basins. Deep dives and extensive sampling of the large sediment fans formed during this period have shown a predictable sediment-distribution pattern that can be related to ancient deposits of similar origin.

Colored motion pictures, taken during scuba dives and from deep submersibles, show presently active processes of sedimentation and erosion in submarine canyons and associated deep-sea fans. Similar pictures, taken during dive traverses off Southern California, and Baja California, Mexico, show the relations of prograding slope sediments to the deeply submerged terraces, associated sea cliffs, and shallow-water sediments.

JOHN JAMES PRUCHA, Syracuse University, Syracuse, New York

Sedimentary Rock Deformation Related to Structure in Basement

Petroleum exploration and development in areas of deformed sedimentary rocks commonly must be concerned with the interrelations between sedimentary rock deformation and the structure of the basement. Concern with the changes in the nature and attitudes of structures with increasing depth, and increased emphasis on understanding regional structural styles, necessitate an understanding of expected basement behavior during deformation of the overlying sedimentary rocks.

The *basement* comprises those igneous and metamorphic rocks of the earth's crust which unconformably underlie the unmetamorphosed, dominantly sedimentary rocks of a particular region. As defined here the term bears no connotation of specific age. Although for most of North America the basement is Precambrian, it is Mesozoic in parts of California and Paleozoic in parts of the New England Upland the Appalachian Piedmont.

The widespread occurrence in the basement of severely deformed metasedimentary rocks in association with igneous intrusives typically reveals a long and complex history of deformation under confining pressures ranging up to 5,000–8,000 bars and at temperatures commonly in the order of 300°–800°C. Thus the environment which originally produced the basement rocks was much different from that of the relatively low energy levels in which the overlying sedimentary rocks were deposited and subsequently deformed, and the resulting mechanical properties of basement-type rocks are very different from those of most sedimentary rocks.

It is clear that the interface between the basement and the overlying sedimentary rocks is a mechanical discontinuity as well as a stratigraphic and structural one. Especially in those regions where the basement was closely involved in the deformation of the superjacent sedimentary rocks is a knowledge of the expected mechanical behavior of the basement essential to understanding the regional structural framework and the changes in the nature and attitudes of local structures with increasing depth. Triaxial compression tests by several workers on typical basement rocks indicate that the expected mode of failure of the basement in submetamorphic environments is principally fracturing and faulting. This is consonant with numerous field data from many structural provinces in North America and elsewhere.

Present understanding of sedimentary rock deformation related to basement structures is best for regions of relatively thin sedimentary cover, such as in the foreland of the Rocky Mountains. Here the dominant structure of the Laramide orogeny is basement block faulting of diverse trends and great structural relief. Individual blocks are bounded by upthrust faults which commonly die out upward into monoclinal flexures in the overlying sedimentary rocks. Horizontal compression structures on a wide range of scales may be formed even though differential vertical uplift characterizes the fundamental structural style. The deformation of the sedimentary rocks is demonstrably a direct result of differential movement of discrete fault blocks in the underlying basement. This style of deformation, so well defined in the Rocky Mountains foreland, is at least partly developed in other structural provinces where differential vertical uplift of a rigid basement with a sedimentary rock cover has been recognized.

The roles of lithologic inhomogeneities and fabric anisotropies of the basement in controlling the locus and style of basement-related deformation of sedimentary rocks are complex and not well understood. Pertinent experimental work on the problem is very limited in amount and scope, and field data commonly are conflicting and inconsistent. The much-cited "zone-of-weakness" concept of basement-related structures is deemed not to have real operational significance in the present state of knowledge, but it remains a promising field for continued study.

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