of about 65 miles are reasonably documented, greater displacements of older rocks are presently speculative and require more precise substantiation.

The late Eocene-to-Oligocene depositional histories of the southern San Joaquin Valley, east of the fault, and the Santa Cruz Mountain region, west of the fault, are symptomatic of a genetic relation. The upper Tejon, San Emigdio, Pleito, and lower Temblor Formations of the San Joaquin Valley are believed to be homologous with the San Lorenzo, Vaqueros, and lower Hester Formations of the Santa Cruz Mountains. No comparable sequence of rocks is known from intervening areas adjacent to the San Andreas fault; therefore post-Oligocene movements of about 225 miles are confirmed.

The late Eocene-to-Oligocene foraminiferal lineage of *Uvigerina jacksonensis* ↔ *U. tumeyensis* ↔ *"Siphogenerina" nodifera* ↔ *"S." transversa* occurs in both regions and corroborates the age relations of the formations.

LAPORTE, LÉO F., Department of Geology, Brown University, Providence, R.I.

RECOGNITION OF TRANSGRESSIVE CARBONATE SEQUENCE WITHIN EPEIRIC SEA: HELDERBERG GROUP (LOWER DEVONIAN) OF NEW YORK STATE

The regional Late Silurian-Early Devonian marine transgression of the central Appalachians is represented in New York State by a shallow-water carbonate rock sequence (Helderberg Group) which locally transgressed north and west. The resultant stratigraphic section comprises several hundred feet of fossiliferous limestone which has several distinctive sedimentary facies.

Early workers interpreted each of the major facies as a separate time-stratigraphic lithologic unit or formation. However, from detailed field examination Rickard (1962) demonstrated that these formations are in fact time-transgressive toward the west and interfinger laterally with each other. Paleoecological study of the Helderberg Group supports this interpretation and shows that each of the formations represents a local sub-environment within the transgressive interval as a whole. These formations (facies) are:

(1) *Manlius Formation* (25–50 feet), a complex of rock types interpreted to represent supratidal, intertidal, and shallow subtidal environments within a broad shelf lagoon (Laporte, 1964; 1967).

(2) *Coeymans Formation* (20–100 feet), crinoidal-brachiopod skeletal calcarenite and carbonate siltstone which are commonly burrow-mottled toward the base of the unit but which show increasingly greater evidence of current reworking toward the top (high-and low-angle cross-stratification and sheet deposits). The Coeymans is interpreted to have been deposited in a wide belt of shallow, submerged crinoid mounds and banks which served as an effective, though discontinuous, barrier to circulation separating the more open-marine environment on the east from the restricted shelf lagoon of the Manlius on the west (Anderson, 1965).

(3) *Kalkberg Formation* (50–100 feet), highly burrow-mottled carbonate mudstone with a very abundant, diverse, and well-preserved biota. The Kalkberg is interpreted to be a shallow-water, open-marine deposit which developed on an extensive shelf seaward from the Coeymans crinoid banks and meadows.

(4) *New Scotland Formation* (50–150 feet), highly argillaceous and siliceous carbonate mudstone with a somewhat less diverse and abundant biota than the Kalkberg. The New Scotland is interpreted as having developed on a broad shelf like the Kalkberg (and marginal to it), but with significantly greater influx of terrigenous detritus which probably came from a distant easterly source.

Lateral and vertical variations in constituent carbonate-grain types, mudstone-sparite ratios, fossil abundance and diversity, and presence of primary sedimentary structures provide criteria for recognizing the transgressive nature of the major sedimentary facies of the Helderberg Group. The inferred depositional framework, moreover, is very similar to that postulated by Shaw (1964) and Irwin (1965) for "clear water" sedimentation within an epeiric sea and demonstrates the predictive validity of their generalized sedimentary model.

LEDINGHAM, GLEN W. (see Frankl and Cordry)

LOWENSTAM, H. A., California Institute of Technology, Pasadena, Calif.

ECOLOGIC CRITERIA FOR RECOGNITION OF DEPOSITIONAL ENVIRONMENTS IN CARBONATE ROCKS

Carbonate skeletons of many Recent and fossil species show morphologic characters which can be related to specific factors in their environments. Similarly, the mineralogy and chemistry of the carbonate from the skeletons are known to reflect a variety of ecologic factors.

Few attempts have been made to utilize the ecologic information from the physical and chemical properties of skeletal carbonates in the analyses of depositional environments of carbonate rocks.

Data are presented to illustrate their usefulness in recognizing certain ecologic factors in the depositional environment of carbonate rocks. In this presentation, particular emphasis is placed on comparative functional morphology of carbonate skeletons. Ecologic factors to be considered are habitat, derivation of constituent grains, rates of sedimentation, turbidity, micro-hydrography, consistency of the sediments, temperature, and depth of the accumulating sediments.

MARTIN, PAUL S., Geochronology Laboratories, University of Arizona, Tucson, Ariz.

POLLEN STRATIGRAPHY OF PLAYA LAKES

Since the discovery 15 years ago by Sears and Clisby that the dry lakes (playa lakes) of western North America contain a rich fossil pollen record, Pleistocene specialists have hoped that a definitive chronology would be forthcoming from this largely unglaciated region. Such a chronology should indicate the number of pluvial episodes and the magnitude of each. The deepest drill cores should reveal whether the Pleistocene began with a "bang" or a "whimper."

Though hopes for a continuous Pleistocene chronology go largely unrealized, the pollen record of the last glacio-pluvial maximum, the Wisconsin, is increasingly well known. It indicates a major shift in vegetation zones not once but several times during the C-14-datable part of the record. Among the areas studied to date are the San Augustin Plains, the Willcox Playa, Great Salt Lake Desert, and the Texas High Plains. Some control on the fossil pollen record can be gained from the modern pollen rain of "natural" plant communities in the southwest. Despite formidable problems of long-distance transport of certain pollen types it appears that the major vegetation zones have their own distinctive local pollen pool,