gillaceous strata alternate with gray to black, brackish, calcareous-arenaceous-argillaceous strata. The red formations pinch out or change facies toward the north and east in the basin. Marine deposition was continuous from Late Cretaceous to early Tertiary in the eastern part of the basin. A few redbeds grade down depositional dip into gray, marine strata. Red strata have been discovered in the Upper Cretaceous Parras Shale, which normally is a gray to black, calcareous shale, 4,000–5,000 feet thick.

During Paleocene or Eocene time, the sediments of the Parras basin were deformed contemporaneously with the adjacent Sierra Madre Oriental. Deformational intensity in the Lower Cretaceous carbonate rocks of the Sierra Madre appears related to the distribution and thickness of the Minas Viejas (Jurassic?) evaporites. The type and degree of deformation in the Upper Cretaceous Parras basin is not uniform as indicated by the following: (1) overturned folds and imbricate thrusts, which probably do not extend below the Parras Shale, characterize the constricted western part of the basin; (2) broad, elongate, open folds in the southeastern part extend downward to folds in Lower Cretaceous strata; and (3) broad, open, domal folds in the northeast are related to Lower Cretaceous uplifts on the surface and at depth.

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SYSTEMATIC INTERPRETATION OF UNCONFORMITIES

The term unconformity is applied to first-order discontinuities which bound major continental framework sequences. Regional and interregional identity and continuity of most unconformities have remained unappreciated because: (1) they normally are erased in many areas by later degradation; (2) empirical criteria are inconsistently developed and commonly obscure the unconformities; (3) most empirical criteria do not make it possible to distinguish between unconformities and countless small-magnitude discontinuities; (4) conventional stratigraphy is depositionally, but not degradationally, oriented; (5) unconformably separated sequences commonly are erroneously equated and thus mistakenly interpreted as facies; (6) miscomprehension of the base-level concept has resulted in failure to relate episodically contemporaneous marine, non-marine, and volcanic successions; (7) individual unconformities are too commonly conceived to be of a single type rather than to represent several or all types; (8) diagnostic faunas commonly are absent from critical strata; and (9) many biostratigraphic standards are inadequate to define unconformities.

Failure to recognize these obstacles has led in many cases to the fallacious expedient of interpreting events directly from the unconformity-riddled and thus degradationally fragmented stratal record. As a result, the occurrence of alternating interregional depositional and degradational episodes generally has remained unappreciated, and many conventional interpretations are erroneous.

Because all unconformities have certain phenomena in common, particularly in regard to their manner of development, and because the beds above and below an unconformity repeatedly have certain relations to one another and to the unconformity separating them, certain axioms and corollaries can be stated that apply specifically to unconformities. It is believed that analytical procedures devised and carried out in the light of these axioms and corollaries provide a systematic basis for the interpretation of unconformities and for their distinction from the myriads of minor breaks.

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QUANTITATIVE APPROACH TO NATURE AND AREAL VARIABILITY OF FOLD GEOMETRY

For describing variations of fold style, orientation, and location, quantitative scalar variables are preferred to quantitative vectoral or qualitative attributes. T. V. Loudon showed that useful quantitative data are obtained if fold profiles are subdivided into one-wavelength units, and if the inclinations (Θ), from the principal axes, or normals to the folded surfaces are measured; the orthogonal principal axes are defined first by factor analysis. The first four statistical moments of these cos Θ values provide scalar descriptors of mean slope, tightness, asymmetry, and shape, respectively. Additional scalars include direction cosines of the principal axes, kurtosis and skewness of the cos Θ values, and the ratio of profile length to wave length.

Vectoral fold attributes plotted on Schmidt equal-area projections necessarily divorce measurements from geographical locations. Scallars facilitate the drawing of contour maps of the areal variability of fold geometry. Surface-trend analyses, widely used in stratigraphic and petrographic research, are used to illustrate regional changes in fold terranes.

Scalar descriptors are useful also in sequential, multivariate regression analyses to search for those geologic factors that controlled the nature and regional variability of folds. Such methods have potential in analyzing subsurface folds for water or petroleum-resource studies. Examples are based on correlations of regional fold patterns with (a) variations of member thickness, lithology, cementation, stratigraphy, *etc.* and (b) proximity to major tectonic features. Such methods are valuable for prediction and permit quantitative testing of hypotheses, *e.g.*, that fold styles in an area (a) change progressively with metamorphic grade or (b) are dissimilar in sandstone and limestone.

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PROBLEMS IN BIOSTRATIGRAPHY AND TAXONOMY OF MIDDLE LIASSIC AMMONITES OF ALPINE-MEDITERRANEAN PROVINCE

The zonation of the Lias (Lower Jurassic) of the Northwest European ammonite province has been worked out in great detail and is based on very careful collecting from representative sections. It recently has been summarized thoroughly by Dean, Donavon, and Howarth (1961). In contrast, the zonation of the Pliensbachian Stage in the Alpine-Mediterranean province still is inadequate, despite extensive descriptive literature. There are several reasons for this.

1. Authors of ammonite monographs usually do not take into account the distinctive character of this faunal province, which requires zonation of its own, based on indigenous index forms. Efforts to correlate these assemblages with the classic zones established in Germany and England have led mostly to confusion.

2. During the Early Jurassic, most of the Alpine-Mediterranean province was undergoing a rapid and complex change of paleogeographic pattern, reflected in extreme heteropic differentiation. This process,

highly irregular in time and space, commonly was accompanied by penecontemporaneous tectonic disturbances and hence anomalies in sedimentation, such as reworking, condensation, and gravity sliding. These complicating and potentially distorting factors usually have not been considered by those few authors who based their descriptions on material newly collected from measured sections rather than on material already existing in some museum collections. As a result, knowledge of the true vertical range of persistent and characteristic species, which would lead to the recognition of suitable index forms, is lacking.

3. Partly because of the two reasons just stated, the taxonomy of ammonite genera and species of this province is in need of revision. Many misidentifications and erroneous generic interpretations have to be corrected, particularly in the families Dactilyoceratidae and Hildoceratidae, both characteristic of the Mediterranean province.

Encouraging contributions to a clarification of the situation have come recently from studies of sections in Morocco, Portugal, and southwestern France. As a result of these studies, the two faunal provinces do not appear to be as distinctive as was previously assumed. In some of these sections, the provinces overlap, particulary in the Domerian Substage, thus making it possible to correlate a Mediterranean zonation based on hildoceratids with the established northwest European zonation based on amaltheids.

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Conodont Zones and Stratigraphic Variability in Upper Devonian of Ontario

A 259-foot section of the Upper Devonian Kettle Point Formation in a cable-tool-drilled well is almost a complete section of the formation. Species of platform-facies conodonts occur in a sequence which correlate with zones defined by Ziegler (1958, 1962) and indicate that almost the entire Upper Devonian is present. Certain zones can not be recognized because the specimen yield is too low; correlation with the standard Upper Devonian ammonoid zones is cited.

The rock is black shale, but the section can be divided into four parts on the basis of the presence or absence of gray silty shale. The stratigraphic distribution of mineralogical and paleontological entities is noted and the following seem to have a common association: (1) black shale, pyritized sponge spicules, *Tasmanites* Newton 1875, and pyritized Radiolaria; and (2) black and gray shale, euhedral pyrite, and abundant conodonts; worm burrows, *Lingula* Bruguière 1797, and fish scales occur in the lower sequence of gray beds but not in the upper.

The sequence is interpreted as representing deposition in a basin with gradually increasing water depth. The stratigraphic variation of the conodonts and their apparent inverse relation with Radiolaria suggest that the conodont-bearing animals lived in the shelf areas of the sea. Conclusions based on a single drill hole are tentative.

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Relict Lyellicerid Fauna of Texas and Northern Mexico

Lower Cenomanian ammonites have been described from the Pawpaw Formation, the Main Street Limestone, the Grayson Formation, the Del Rio Claystone, the upper part of the Georgetown Limestone, and the Buda Limestone of Texas and northern Mexico. The fauna of the Buda Limestone, in particular, is dominated by a distinctive group of lyellicerid ammonites of the genera *Faraudiella* and *Budaiceras*.

The greatest number of lyellicerids in Texas consists of 13 species from the Buda Limestone (zone of *Budaiceras hyatti*). These species occur with *Mantelliceras* sp. cfr. *batheri* Spath, *M.* sp. cfr. *hyatti* Spath, and *M. cantianum* Spath (=*M. budaense* Adkins), all of which have been collected from the Buda Limestone. They represent the *cantianum* zone and probably the upper part of the *martimpreyi* zone of western Europe.

In Europe lyellicerids (*Stoliczkaia*) do not range above the *martimpreyi* zone, and *Faraudiella* is said not to range higher than the Albian. There are mantellicerid species common to Texas and Europe, but there are no Cenomanian lyellicerid species common to Texas and Europe. If the *Mantelliceras* species are used for correlation, the *Budaiceras* fauna of Texas and northern Mexico would seem to represent a relict lyellicerid group that lived in the restricted environment of that area after lyellicerids had disappeared from the rest of the world.

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Differentiating Shelf and Marine Sands from Deltaic and Brackish-Water Deposits Using Modern Techniques

The common occurrence of oil and gas in sandstone within stratigraphic sequences composed of interstratified marine and non-marine sediments, formed in environments at or adjacent to a shoreline, is well known to most geologists. Such gross relations are ascertained readily, but the nature and mode of origin of individual sandstone bodies generally have been of little concern. It is probable that these sequences must include sandstones of both marine and non-marine origin. Marine types to be expected include beach, shoal, and shelf sandstone; whereas, non-marine types include deltaic, estuarian, paludal, and lagoonal sandstone. Knowing the mode of origin of sandstone in a petroleum-bearing sequence should be of considerable importance. One type may never contain oil; some sandstone types may contain petroleum in predictable, more permeable zones; some types may be long and sinuous and others broad and sheet-like; some may parallel old shorelines whereas others may be at right angles to them.

Positive determination of the genesis of a sandstone, either at the outcrop in the subsurface, is difficult, but can be done with some assurance by using multiple criteria—no one of which is entirely diagnostic and only a few of which may be ascertainable for a particular sandstone body. Parameters of value in determining origin include geometry of the sandstone body, sedimentary structures, log characteristics, composition, nature of boundaries, and composition of surrounding or enclosing sediments.

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Conodont Zonation of Upper Devonian in Central Europe

Conodont investigations in the German standard