Heat-Flow and Heat-Production Studies in North Dakota

Thirty-one new heat-flow determinations made in both oil and water wells in North Dakota range from 0.6 to 1.9 HFU.

Heat-production data from basement rocks used with nearby heat-flow values indicate that only two of six sites may be considered to be similar to Basin and Range values for heat flow. One site occurs in southwestern North Dakota in a region west of 103°W where no heat-flow value is less than 1.5 HFU. The other site in north-central North Dakota is problematic, but an eastern United States interpretation is favored. The remaining four sites are interpreted as eastern U.S. values.

A transition in heat-flow character from eastern United States values to Basin and Range values occurs west of 103°W long. in southwestern North Dakota. The narrow width (28 km) of the transition zone between heat-flow provinces implies a shallow depth to partly molten lower crust or upper mantle.

The heat-flow results coincide with a zone of anomalous electrical conductivity. When used with experimental petrologic data for peridotite in the presence of excess water, temperature calculations suggest that a partial melt zone begins approximately at 45 to 55 km, which coincides with crustal thicknesses from seismic refraction data for southwestern North Dakota.

For southwestern North Dakota, uplift of the badlands appears to be a result of partial melting.

If the high heat-flow region extends northward into northwestern North Dakota, the generation of petroleum was controlled by the zone of high heat flow. This interpretation implies that source rocks are depleted in their mobile petroleum components within the region of high heat flow.

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Biostratigraphic Problems Generated by Deep Sea Coring—Biosystematic Analysis, Evolutionary Species, and Non-Validity of Lineage Zones

Recent availability of stratigraphically continuous and hiatus-free sequences of pelagic sediment in deep sea cores have encouraged biostratigraphers to interpret lineages of oceanic microfossils from a viewpoint of gradual phyletic evolution. A few taxa do show anagenetic evolution, but the excellent stratigraphic record obtained from deep sea coring reveals that the overwhelming majority of species show only cladogenetic evolution with no gradual speciation. Biostratigraphers nevertheless persist in recognizing ancestral-descendant relations whenever possible, and arbitrary limits must therefore be applied when an evolving lineage is divided. This typological practice may be good biostratigraphy, but it is poor biosystematics.

Phyletic biohorizons and lineage zones are explicitly defined and recognized by evolutionary criteria. For interpretation, these horizons and zones must rely on notions of phyletic gradualism and ancestor-descendant relations. These notions must rely on an evolutionary theory to allow their inference. However, biostratigraphy should not rely on evolutionary theory since biostratigraphy is the means by which we correlate strata to test evolutionary hypotheses about patterns of fossil phylogeny.

For good biostratigraphic practice, evolutionary species should be recognized as single lineages without arbitrary and typological subdivision. Biosystematic analysis should begin with a cladogenetic analysis which infers taxon relations from characters exhibiting shared derived similarities. Classification should immediately follow to preserve the monophyletic relations of the clades. This system results in universal and timeless taxonomic hypotheses which are potentially falsifiable and thus scientifically testable. A biozonation based on such taxa is independent of evolutionary theory. Untestable assumptions and ad hoc hypotheses of ancestral-descendant relations and gradual speciation, such as must be used to recognize phyletic biohorizons and lineage zones, are unnecessary.

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Seismic Stratigraphy of Atlantic Margin in Vicinity of Chevron COST B-3 Well

Correlation of key seismic reflectors with the lithologic, biostratigraphic, and paleobathymetric logs of the Chevron COST B-3 well shows that this part of the Atlantic continental slope changed from a platform-fringed shelf in the Middle to Late Jurassic and Early Cretaceous to a deep-water slope in the Late Cretaceous and early Tertiary. Closely matching paleobathymetric and eustatic sea-level cycles indicate that sea-level fluctuations strongly regulated deposition by cyclically shifting the loci of deposition among the shelf, slope, and rise. At the same time, the alternate loading and unloading of the shelf may have accentuated the relative change in sea-level by producing corresponding cycles of isostatic subsidence and rebound.

Some major seismic reflectors beneath the shelf appear to coincide with erosional disconformities formed during early Oligocene, early Paleogene, early Turonian, and early Barremian. Reflectors of Late Cretaceous through early Tertiary age are continuous from the present shelf to beneath the present rise; their continuity, seismic character, and structural geometry support the idea that the margin was broadly constructional during this interval and that the shelf break was poorly defined. Beneath the rise, reflectors are mainly conformable; their character suggests onlapping fill and slope-front fill facies. Broad downslope channels were cut during the middle Tertiary and late Quaternary presumably in response to major drops in sea level.

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Continental Stretching—Explanation of Post-Mid-Cretaceous Subsidence of Central North Sea Basin

The North Sea is a major continental basin filled with sediments ranging in age from early Paleozoic to recent. It has been active several times in the past. Since the last epoch of activity, extending from the Middle Jurassic until the Early Cretaceous time it has been queiscent and the Central graben has been filled successively by chalks, sandstones, and, finally during most of the Tertiary, by shales or mudstones. The rate of subsidence of the basin, calculated by plotting observed depth in hole versus time, during this quiescent period appears to increase in the later stages. However, when compaction, water depth of deposition, and sediment load are considered, the rate of subsidence of the basement becomes close to linear trending to exponential.

Between 50 and 100% stretching of the Central graben during the last epoch of activity can account for the observed amplitude and rate of subsidence. Such stretching is compatible with the measured heat flow and though there is no actual seismic refraction data across the Central graben this explanation is strongly supported by evidence of a thinner crust under the Viking, Witchground, and Buchan grabens to the north. A geologic model based on stretching which can account for the Jurassic and Early Cretaceous faulting and the general post–mid-Cretaceous saucer-shaped basin is presented. On the basis of this model the thermal maturity and hydrocarbon potential of certain sedimentary horizons in the northern part of the Central graben are examined.

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Early Cretaceous Reef Communities in Gulf Coast

The development of paleocommunity concepts has led to new hypotheses of Cretaceous reef structures. Important biota of Early Cretaceous Tethyan reefs were corals and algae, besides various rudists. Different communities produced distinct structures upon shelf margins, interior shelves, and carbonate ramps. Further, the communities changed through time as rudists evolved. This change in community structure influenced the types of reefs prevalent at different times.

Bound framework associations consisted of coral skeletons thickly encrusted by algae and stromatoporoids and cemented by micrite soon after deposition as indicated by buried erosion surfaces. Boring organisms generated large amounts of micrite as well. Caprinids, radiolitids, and monopleurids are sparse. Bound frameworks developed upon Early Cretaceous shelf margins and carbonate ramps.

Mobile associations consisted of caprinids, radiolitids, and toucasiids encrusted by algae within a loose gravel of skeletal debris. Micrite and sparry cement are both well developed. Mobile associations formed passive banks in the shallower parts of the shelf margin and in high energy parts of the interior shelves. These buildups became important in the Aptian and later replaced the bound frameworks in the Late Cretaceous.

Stable associations consisted of caprinids, toucasiids, monopleurids, radiolitids, and caprotinids surrounded by calcareous mud. Many shells were thinly coated by algae and bored by sponges, among other organisms. The shells still are in a stable growth position. Micrite cement originally was more abundant than spar between grains. These biostromes, thickets, and coppices developed mainly upon interior shelves during Aptian to Maestrichtian time.

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Temperature and Pressure Relations in Thick Sequences of Accumulating Sediments

The various processes involved in fluid flow and thermal energy transfer in major sedimentary basins are closely interrelated. The major thermal energy transfer processes appear to include conduction, convection by upward-moving pore fluids both on discrete and diffuse scales, and possibly endothermic or exothermic reactions. Fluid flow in sequences of accumulating sediments is predominantly the result of excess pressures. These excess pressures were probably produced by compaction disequilibrium and aquathermal pressuring. The latter is strongly temperature dependent as are several other secondary causes of excess pressuring. The combination of pressure-producing factors may create conditions for natural hydraulic fracturing and for subsequent pressure dissipation and upward convection of heat. The pressure and temperature distributions in accumulating sedimentary basins are strongly dependent on (1) the thermal and hydraulic conductivities of the sediment, (2) the rate of sediment accumulation, and (3) the geothermal gradient.

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Paleogeography and Marine Communities of Silurian Carbonate Shelf in Utah and Nevada

Silurian shelf sea communities can be used as a tool in the interpretation of depositional environments in the Great Basin. The Laketown Dolomite was deposited in a shelf sea adjacent to the Silurian margin of the North American plate. Initial deposition began in the middle Llandovery and continued into the Wenlock. Shallow-water communities include a time-sequence of pentamerid communities in shallow, rough water and a dasyclad algae community in shallow, calm water.

Basins to the north and south of the Tooele arch formed in the late Llandovery. The northern basin was nearly filled by the end of the late Llandovery. The southern basin continued to deepen during the early Wenlock but was filled by the middle of the Wenlock. Communities from the basins reveal that the southern basin attained a greater water depth than did the northern basin. With increasing depth, brachiopod guilds were progressively more diverse while shell size and robustness decreased.

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Uranium Deposits of Part of Central Great Divide Basin, Wyoming

Economic uranium deposits occur within tabular, arkosic sandstones of a large Eocene "wet" fan complex known as the Battle Spring Formation in the central Great Divide basin. These "roll-front"-type deposits are located where the fan complex intertongues basinward with finer-grained fluvial, paludal, and lacustrine facies of the Wasatch and Green River Formations.