SLOSS, L. L., Northwestern University, Evanston, Illinois

BASEMENT INFLUENCES ON TECTONIC CYCLES IN BASINS

Although direct information from deep boreholes and indirect data from geophysics add significantly to interpretations, the geometry and composition of the basin fill remain the most fruitful fields from which to draw inferences on the behavior of major sedimentary basins. Geometric and compositional data are capable of analysis to yield interpretations through geologic time of the rate of subsidence in basins, their degree of differentiation from surrounding neutral and positive elements, the positions and stability of the hingelines along which such differentiation is accomplished, and the position and character of source areas contributing to the basin fill.

Evaluation of the sedimentary record of basins in the interior of the North American craton indicates that, for the period since late Precambrian, such basins, in harmony with the rest of the craton, have been involved in six major sedimentary cycles. Four of these, corresponding with the times of accumulation of the Sauk, Tippecanoe, Kaskaskia, and Zuni Sequences, exhibit records of five distinct stages that appear to have simultaneous effects on all cratonic basins. None of the cratonic cycles shows any systematic correlation in space and time with orogenic events in extracratonic mobile belts.

These essentially stratigraphic deductions raise questions that require consideration in the development of geologically meaningful basin models. Such models must include simultaneous consideration of the composition, structure, and dynamics of the continental crust and upper mantle.

SMITH, J. R., AND ARNOLD, R. G., Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada

X-RAY FLUORESCENCE DETERMINATION OF NI, CU, AND ZN IN ROCK POWDERS WITH VARIABLE MATRICES

A precise and rapid X-ray fluorescence technique has been devised for measuring concentrations of Ni, Cu, and Zn in the range from zero to 5,000 ppm in undiluted and unfused samples of powdered rock. The crux of the method is the use of primary WLα radiation coherently scattered and partly absorbed by the sample as a measure of the absorption characteristics of the sample for the X-ray wavelengths concerned. The method was calibrated by adding known amounts of Ni, Cu, and Zn to rock powders with a representative range of absorption characteristics, thereby establishing a family of linear calibration curves, each labeled with the associated intensity of the WLα line. Measurement of WLα line intensity could then be used to predict the slope of the calibration curve for any sample.

It was found that WLα line intensity could also be used to predict and correct for "instrumental contributions" of CuKα and NiKα line intensities, and to predict rather than measure background counting levels, thereby shortening analytical time appreciably.

The total time required for the determination of Ni, Cu, and Zn in one sample is about 15 minutes. The method has a precision (standard deviation of a single determination) of about $\pm 4\%$ for Zn, $\pm 5\%$ for Ni, and $\pm 8\%$ for Cu at a concentration level of 70 ppm. Determinations by this method (SRC) are compared with recommended values (USGS) for standard rocks W 1 and G 1 in the following table.

Element	*Concentration*		*ppm by weight*	
	G 1		*W 1*	
	SRC	*USGS*	*SRC*	*USGS*
Ni	11	<10	93	82
Cu	19	13	138	110
Zn	35	40	65	82

The method has greatly accelerated studies of the distribution of traces of ore metals in Precambrian country-rock in Saskatchewan.

SONNENFELD, PETER, Texas College of Arts and Industries, Kingsville, Texas

FAMENNIAN REEFS IN ALBERTA, CANADA

The lowermost 200 feet of the Wabamun group of Famennian age may sporadically display an unusually abundant fauna in the subsurface of Alberta northeast of the then slowly submerging Poaco River landmass. This fauna, composed of stromatoporoids, coralline algae and various rod- and tube-shape bioclastic fragments in a sparry cement, is completely absent in nearby boreholes that show primarily carbonate muds with only rare dwarfed *Foraminifera*, some ostracods, and crinoid stems.

Irregular mounds of medium to coarse cystalline dolomite, which contain stromatoporoids (*Labechia* sp. and *Pseudolabechia* sp.) and relic tube- and rod-shape fragments suggestive of coralline algae and other potential reef builders are found encased in Wabamun carbonate muds. These mounds are restricted to the region of complete or partial dolomitization of the underlying Graminia formation south of this Poaco River landmass. Identifiable specimens of reefal organisms still stand out, even if they are only moderately common in the severely dolomitized sections; they are completely absent in adjacent pelleted or unpelleted carbonate muds. The muds contain a negligible clastic admixture and are populated only by some individual *Foraminifera* of the Nodosaria family, Dasycladaceae such as *Mizzia* sp., ostracods, and crinoids, with an extreme scarcity of biogenic remnants being the really paramount feature.

The Wabamun dolomite mounds appear to occur preferentially near Wabamun thins, on the slopes of the Wabamun sea floor. Such reefal developments are found on slopes formed by the Wabamun being comparatively thicker over buried Frasnian Woodbend reefs, due possibly to some negative adjustments within or below these older reefs during Graminia and Lower Wabamun deposition. Unlike their undolomitized and tight equivalents, the Wabamun dolomite mounds have been cored frequently and thus are accessible to detailed study; they are economically important as attractive gas reservoirs with porosities to 13 per cent, permeabilities up to 200 millidarcys. Dolomitized biostroms previously reported by others from Palliser outcrops near Banff, Alberta, are exposed equivalents of similar magnitude; the carbonate mud encasement renders them akin to Silurian reefs on Lake Erie and James Bay in Ontario.

STEVENS, CALVIN H., Department of Geology, San Jose State College, San Jose, California

PALEOECOLOGIC IMPLICATIONS OF LATE PALEOZOIC FAUNAL ASSEMBLAGES IN WESTERN UNITED STATES

Stratigraphic and paleontologic studies of interfingering marine and non-marine Late Paleozoic rocks in a

small area near McCoy, Colorado, and in a large region in east-central Nevada indicate that at least eight major marine and paralic faunal assemblages occur in rocks of Pennsylvanian and Permian age. The eight recognized major faunal groups are: textulariid, fusulinid, coral, productid-*Composita*, chonetid, *Heteralosia*, *Nuculana*, and *Euphemites* faunas. The textulariid, fusulinid, coral, productid-*Composita*, and chonetid faunas required a salinity close to 35°/$_{oo}$. The textulariid fauna probably lived at a depth of 50–70 m. and perhaps deeper; fusulinid fauna, 20–50 m.; and coral fauna, 10–30 m. The productid-*Composita* and chonetid faunas both may have lived at a depth of 4–10 m., but they had different energy requirements. The *Heteralosia*, *Nuculana*, and *Euphemites* faunas occupied very shallow-water environments with salinities different from 35°/$_{oo}$.

Overlap of faunas appears to have been a more common occurrence in the Colorado area than in Nevada because a greater inclination of the sea floor in Colorado allowed maximum development of different faunas to take place in areas close enough together to permit considerable faunal mixing. Geographic distribution of contemporaneous faunas indicates that inclination of the Colorado sea floor generally was about 10 m./km., whereas the inclination of the Nevada sea floor generally was about 1 m./km.

STEVENS, NELSON P., Socony Mobil Oil Company, Inc., Dallas, Texas

GEOCHEMICAL PROSPECTING—A CRITICAL REVIEW

A recent visit to the Soviet Union confirms impressions from the literature that Soviet geochemists continue to be the most active in geochemical prospecting technology. The All Union Scientific Institute of Nuclear Geophysics and Geochemistry in Moscow has the prime responsibility for research and development of near-surface geochemical prospecting for practical application as a rapid reconnaissance tool, especially in new areas and for stratigraphic traps, in support of geophysics and geology exploration. The major topics of investigation include: vertical migration mechanisms, radiometry, geomicrobiology, soil gas analysis, and gas logging.

In the United States, geochemical prospecting has had an erratic history of research and application, and although credited in whole or in part with some discoveries, it is not generally accepted as a commercially useful tool.

Successful application of near-surface geochemical prospecting requires (1) migration of hydrocarbons from the accumulation to the near-surface zone, (2) detection and identification of these migrated hydrocarbons in micro quantities, and (3) correlation of the observed near-surface distribution of these hydrocarbons with their subsurface source. Modern analytical methods for detecting micro quantities of hydrocarbons in rocks, soil, or soil gas samples are accurate and definitive. Factors complicating the use of geochemical prospecting involve the vertical migration process with the associated complex environmental productive zones, non-commercial occurrences, and intervening source rocks. Field tests indicate that where hydrocarbons succeed in reaching the near-surface zones, they usually do so in the form of seeps of restricted areal extent even at the micro concentration level.

From the initial work of United States and Soviet geochemical investigators 25 years ago, there has developed a sophisticated geochemical technology now making important contributions to petroleum exploration through source bed evaluation, crude oil correlation, formation water analyses, and origin and migration investigations.

STOCKWELL, C. H., Geological Survey of Canada, Ottawa, Ontario, Canada

STRUCTURAL FEATURES OF THE CANADIAN SHIELD

The paper is accompanied by a sketch map showing the main structural and orogenic features of the Canadian Shield. Three main types of structural patterns are distinguished. Regions characterized by high-grade metamorphism or granitic intrusions present swirling and circular structures of extremely complex pattern and relatively little topographic relief. Areas of low grade, folded Proterozoic rocks form linear belts of generally more pronounced relief. Areas of flat or gently folded cover rocks of Proterozoic age form broad sheets of low relief except where cut by diabase sills. The various types of structures found in the exposed Shield may be expected to continue beneath the Phanerozoic cover.

STOTT, D. F., Geological Survey of Canada, Calgary, Alberta

DEPOSITIONAL ENVIRONMENTS OF SOME CRETACEOUS SEDIMENTS, ROCKY MOUNTAIN FOOTHILLS, CANADA*

Excellent exposures of Upper Cretaceous rocks in the central Foothills of Alberta reveal a lateral and vertical succession of marine shale, littoral and near-shore sandstones, and lagoonal to deltaic sediments. The interpretation of the depositional environments is based on comparisons with Recent sediments and on various physical criteria such as areal patterns, structures, and textures. In addition, paleontological data also provide useful information. The intertonguing of deposits records shifting shorelines related to the slowly regressing sea. Delineation of the ancient shorelines suggests areas in which potential reservoir rock may have formed and is important in future petroleum exploration.

Several units are interpreted as having formed in the transitional environment. Some of the sandstones, particularly those of the Cardium formation, are similar to those associated with barrier islands and represent the littoral and upper part of the epineritic environments. The sandstones are finely laminated, show reworking by organisms, and generally are well sorted. They have a linear distribution, extending for hundreds of miles along the Foothills. Associated with those sand bodies are carbonaceous sediments believed to represent lagoonal and marsh deposits. They include coarse-grained sandstone that presumably formed in stream channels, suggesting the presence of a deltaic complex. The abundance of carbonaceous debris and thin coal seams attest to widespread and recurring swamp conditions.

The marine shales are separated into several types, each characterizing a specific zone of deposition. Those formed in an oxidizing environment, presumably above wave base, contain glauconite and siderite. Shales formed below wave base were in a reducing environment that favored the development of pyrite and the diagenetic alternation of calcite to dolomite.

TANGUAY, MARC G., Ecole Polytechnique, Montreal, Quebec

IDENTIFICATION OF CLINOPYROXENES BY X-RAY DIFFRACTION AND OPTICAL METHODS

* Published by permission of the director of the Geological Survey of Canada, Department of Mines and Technical Surveys, Ottawa.