continues, the residual molecules become correspondingly smaller (and lower boiling) and isotopically heavier (higher C^{13} content).

If a material balance is attempted by redistributing the C^{13}/C^{12} abundances of the gas fraction among the various liquid distillate fractions, we arrive at an isotopic composition of the resulting gas-free petroleum that is close to the isotopic composition of the highest boiling fraction. Available data on the isotope effect accompanying the thermal decomposition of simple organic molecules indicate that C^{12}—C^{12} bonds are ruptured about 8 per cent more frequently than are C^{12}—C^{13} bonds. This fractionation is in the same direction and of the same order of magnitude as the fractionations apparently involved in the decomposition of complex petroleum constituents.

These observations, which can readily be explained by assuming that the lighter petroleum fractions are derived from high molecular weight compounds, must be considered in evaluating existing hypotheses of petroleum origin and evolution.

HOWARD A. SLACK, and CAREL OTTE, JR., Pure Oil Research Center, Crystal Lake, Illinois

Electric Log Interpretation in Exploring for Stratigraphic Traps in Shaly Sands

Two quantities which can be calculated from conventional electric logs of shaly sands provide useful reliable information on the reservoir rock and the fluid it contains.

(1) *Shaliness.*—A measure of the amount of disseminated clay material in the formation. This quantity measures the ease with which the rock gives up fluids and also makes an excellent mappable attribute for the construction of subsurface facies maps. The relative agreement between this log-derived property and the results of cation exchange capacity measurements is good.

(2) *Saturation Ratio.*—The ratio of mud filtrate saturation in the invaded zone to the interstitial water saturation in the non-invaded zone. Although it is not considered to be a mappable attribute, the magnitude of this ratio is indicative of the amount of displaceable hydrocarbon in the formation.

The value of shaliness and saturation ratio when viewed together are related to the performance of the formation under production tests. Definite ranges in the values of these quantities are associated with (a) formations which produced hydrocarbons readily, (b) formations which produced hydrocarbons in commercial quantities only when some form of artificial stimulation, such as sand fracturing, was applied, and (c) formations which produced water along with the hydrocarbons.

A single favorability criterion is developed which is a joint function of shaliness and saturation ratio. This criterion attempts to rate numerically the production performance of any given formation on the basis of electric log derived quantities only. Its use in exploration is demonstrated by maps which show how it varies throughout and around known oil fields in shaly sand. It may have value as a means of detecting from dry hole data the proximity to good oil production.

F. J. STEVENSON, University of Illinois, Urbana, Illinois

Nitrogenous Constituents of Some Paleozoic Shales

As much as three-quarters of the nitrogen in some Paleozoic shales was released as ammonia by acid hydrolysis; from 1 to 5 per cent as amino acids. The nitrogen released as ammonia occurred largely as ammonium ions held within the octahedral pores making up the crystalline nuclei of illite clay minerals. The presence of nitrogenous organic constituents within the characteristic expansible layers of silicate minerals was also indicated. The organic matter adsorbed on the internal surfaces of the clay was non-extractable with alkali, but was removed readily through decomposition of the clay with hydrofluoric acid.

A comparison of the organic constituents in shales with those in recent sediments showed that a smaller fraction of the organic matter in shales occurred in protein derivatives. The carbon-organic nitrogen ratio in shales was higher than in recent deposits. The suggestion is made that the transformation of complex organic materials in marine muds consists, in part, of the formation of aromatic compounds from sugar-amine condensation products, and that, concomitantly, nitrogen is lost as ammonia and petroleum constituents are formed.

WILLIAM LEE STOKES, University of Utah, Salt Lake City, Utah

Fluvial and Eolian Sandstone Bodies in Colorado Plateau

The Colorado Plateau has been the site of accumulation and preservation of non-marine sediments since late Paleozoic time. The climatic conditions have been desert-like for long periods and wind-blown sand is a common sedimentary type. Much of the alluvial material did not leave the source area and is still near its place of origin. The deep and intricate erosion permits excellent three-dimensional views of the sedimentary bodies.

Extensive eolian formations occur in the Permian, Triassic, and Jurassic systems. These are mainly interpreted as superposed dune fields. In many instances the edges of the formations are abrupt and comparison with modern sharply defined dune areas is obvious. Tangential cross-bedding with occasional contorted masses characterize these deposits. Chief interest attaches to the determination of wind directions; apparently the source of most of the sand lay to the north and northwest.

Fluvial deposits are common after the Pennsylvanian. These offer excellent opportunity to study sedimentary variations resulting from differences in climate, weathering, distance of transport, provenance, and energy relations of stream systems. The common occurrence of uranium deposits in the fluvial sandstones has stimulated geologic investigation. The petroleum possibilities of these beds are also receiving increased attention.

Practically every type of deposit seen in process of formation in modern rivers can be detected in the consolidated rocks. The overbank or flood-plain deposits are of less variety and interest than the channel deposits. All types of bars and channel-fill deposits are present but those formed during the building of alluvial plains are most common. Apparently the final composition of a typical fluvial formation depends on the gradient of the streams, the total amount of sediment supplied, and the relative amounts of fine and coarse material. Internal structures of channel sandstones show great variety and can be related to stream volume and velocity. Ripple-mark, festoon cross-bedding, rib-and-furrow, and lineation are the most common.