the seismograph has proved to be an invaluable tool in describing potential potash reserves by outlining areas of salt removal. Gravity and magnetic control may help to unveil some lower Paleozoic structural anomalies. The Nelson River gravity "high" appears to suggest the position of the boundary between the Churchill and Superior Precambrian provinces in southeastern Saskatchewan and, therefore, outlines a very interesting trend with respect to lower Paleozoic prospects.

12. LLEWELYN JONES, Geological Sciences Branch, Saskatchewan Department of Mineral Resources, Regina, Saskatchewan

SEDIMENTATION AND ECONOMIC PROSPECTS OF MIDDLE DEVONIAN WINNIPEGOSIS FORMATION OF SASKATCHEWAN

The Middle Devonian Winnipegosis Formation of Saskatchewan is divisible into upper and lower members on the basis of a regionally developed argillaceous interval which forms the uppermost part of the lower member.

The lower member consists of a regionally dolomitized marine carbonate of relatively constant thickness and lithology, attaining a maximum observed thickness of 54 ft. The upper member is a varied marine carbonate sequence, with three major facies developments. In the southwest lies a wedge of lithologically relatively consistent carbonates, reaching a maximum thickness of about 130 ft. along a northwest-trending axis extending through Weyburn and Elbow. In the north and east, bioclastic-pelletoidal carbonate banks with true reef intervals (up to 345 ft. thick), and finely laminated, interbank carbonates (up to 68 ft. thick) occur.

The lower member was laid down in a broad epicontinental sea. The relatively shallow, open marine conditions culminated on two occasions in basin-wide, reducing, lagoonal conditions, evidenced by the medial and upper very bituminous argillaceous intervals containing impoverished faunas. The upper member appears to have been deposited in a shallow shelving sea which deepened toward the northeast. Using a regionally developed *Amphipora* zone as a datum, three pre-*Amphipora* tectonic-sedimentational regions are discernible: in the southwest, the Elbow-Weyburn basin, subsiding relatively rapidly to accommodate thick, shallow-water carbonates; in the north and east, the comparatively stable Saskatoon shelf, with thin laminated carbonates and basal carbonates of the bank sediments; and the more rapidly subsiding Meadow Lake-Sayese basin complex, with similar sediments, except that bank sedimentation was further advanced. In post-*Amphipora* time, subsidence continued in the north, accelerated in the shelf area to accommodate thick bank accumulations, whereas, in the southwestern basin, carbonate deposition was almost complete.

Although no commercial quantities of oil or gas have been found in Saskatchewan, production of oil from the Winnipegosis in the Outlook and Redstone fields of northeastern Montana is encouraging. The occurrence of oil and gas "shows" in some drill-stem tests and of oil staining in the Winnipegosis Formation in Saskatchewan offers further encouragement, especially in the Elbow-Weyburn basin, which is a northwestern extension of the oil-producing facies of northeastern Montana. The presence in the southwestern basin of permeability traps resulting from differential dolomitization and recrystallization, and. in the north and east, of important thickening in short distances, associated with variably porous bank carbonates, together with the widespread development of an excellent top seal in the form of the Prairie Evaporite salt or carbonate-anhydrite sequences, provide excellent conditions for the entrapment of hydrocarbons.

13. FRANK A. RADELLA, Consulting geologist, Billings, Montana

NISKU OF NORTHEASTERN MONTANA WITH SPECIAL REFERENCE TO TULE CREEK AREA, ROOSEVELT COUNTY, MONTANA

Oil accumulations of the Tule Creek area, that are found in the Devonian Nisku Formation, are a result of structural and stratigraphic conditions. Present-day productive structures have about 50 ft. of closure. These structures occur in an area of favorable Nisku patch-reef environment that was subjected to secondary dolomitization.

The Nisku of the Tule Creek field consists of anhydrite, limestone, and dolomite and averages 81 ft. in thickness. The upper one-third of the formation is primarily anhydrite and the lower two-thirds are dolomite. Some limestone always is present in the middle of the anhydrite unit. In the lower two-thirds, where found off structure, the unit is non-productive and(or) out of the favorable facies.

Oil production is from vuggy and intercrystalline porosity and permeability developed by secondary dolomitization. Occasional high-angle fractures contribute only slightly to the over-all reservoir productivity. Abundant relict *Amphipora* and lesser amounts of algae are apparent in the dolomite and appear to be the primary host for the dolomitization process. Only minor amounts of *Amphipora* are found in the non-dolomitized carbonate strata.

On structure, oil-productive dolomite consists of large-sized rhombohedral crystals oriented randomly or in point-to-point contact, improving the primary porosity and creating excellent permeability. The lesser dolomitized, non-productive, off-structure Nisku exhibits good apparent log porosity but very low actual effective permeability. These off-structure dolomites are finer-grained, slightly to moderately calcareous, and have a face-to-face crystal orientation.

The favorable patch-reef facies of the Nisku Formation is controlled by environment and trends locally in a southwest-northeast direction.

Structural closures that occur in the favorable facies area contain reservoir rocks with excellent porosity and permeability.

With a 24-ft.-thick anhydrite bed above the "pay" zone, a 10-ft.-thick dense anhydritic shale (Ireton Member) below, and a lack of extensive fracturing, the Nisku is postulated to be its own source rock.

14. GEORGE H. MURRAY, JR., Consulting geologist, Billings, Montana

QUANTITATIVE FRACTURE STUDY—SANISH POOL, MCKENZIE COUNTY, NORTH DAKOTA

The Sanish pool of the Antelope field has a number of unusual facets which make it almost unique in the Williston basin. Some of these are: (1) high productivity of a number of wells from a nebulous, ill-defined reservoir; (2) association with the steepest dip in the central portion of the basin; (3) very high initial reservoir pressure; and (4) almost complete absence of water production.

Analysis of these factors indicates that Sanish productivity is a function of tension fracturing associated with the relatively sharp Antelope structure. A relationship between fracture permeability and structural