only a 35-ft-thick equivalent of the Sundance. Particularly useful in correlation are purple and ocher analcime-rich rocks of the Popo Agie; the various units of the Redwater Shale Member and underlying member of the Sundance; and unconformities at the top of the Popo Agie, and at the base, in the middle, and near the top of the Sundance. The unconformity at the base of the Sundance is of Middle Jurassic age and is characterized by chert pebbles which occur in an area extending from the northeastern corner of Wyoming to Zuni, New Mexico (700 mi), and from the San Rafael Swell, Utah, to Boulder, Colorado (300 mi).

The Jelm extends from Wyoming about 50 mi into north-central Colorado. The Popo Agie and the lower and upper parts of the Nugget of central Wyoming correlate with the lower and upper parts of the Chinle, and with the Glen Canyon of the Uintas, respectively. The Gypsum Spring as defined at the type section is represented by the unconformity beneath the chert-pebble zone at Manila, Utah, on the north flank of the Uintas. The Sundance correlates with the Curtis and Entrada, and possibly with part of the Carmel of Manila, Utah.

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Exploration Progress in Alaska

(No abstract submitted)

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Geothermal Energy

The search and utilization of geothermal energy commenced in Italy in the early 1900s. Today, Italy produces sufficient power from geothermal energy to operate its entire network of electric railroads. This amounts to approximately 400,000 kw.

One hundred areas in 15 different countries are being explored for geothermal energy. Other countries which are currently utilizing geothermal energy are: Iceland, for domestic and industrial heating; Japan, for electrical power and recovery of salt from sea water; and New Zealand, U.S.A., and Mexico for electrical power.

The Geysers area of northern California was first investigated for its geothermal potential in 1922. The project was not successful as there was sufficient electrical power being produced from fossil fuel and by hydroelectric plants.

The rapid industrialization and population explosion in the western states have led to an increase in demand for energy. From 1945 to 1960, electrical power production increased 239% for the nation and 252% in the western states. The FPC predicts a 275% rise nationally by 1980, based on 1960 power demands, with a forecast of 320% rise for the western states. To meet these demands for electrical power, all forms of energy known to man must be harnessed.

The first commercial geothermal power production, in the United States, began at The Geysers in 1960 at the rate of 12,500 kw. In April 1967 the capacity was increased to 56,000 kw. It is estimated that the capacity can be increased to 1,000,000 kw.

Recognizing geothermal energy as a source of power, the U.S. Geological Survey is conducting a nation-wide investigation of all geothermal areas which may have this potential. The state Bureaus of Mines of California, Oregon, Nevada, Utah, and New Mexico have conducted their own studies to evaluate their geothermal areas.

Locating a geothermal area which may have commercial power potential is difficult. The most obvious areas of hot springs and geysers currently are being investigated. It is conceivable the areas which may hold the greatest potential cannot be detected at the surface.

The drilling and development of a geothermal area are extremely hazardous and expensive, but technical problems will be solved, and costs reduced, as future increased power demands escalates the exploration for geothermal power.

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Bituminous Sandstone Deposits of Utah

(No abstract submitted)

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Breaking Geological Communication Barriers

Although considerable attention has been given in recent months to geological obsolescence and scientific upgrading of the geologist, communication deficiencies pose a greater problem for geologists than does professional competency. These barriers result not only in unemployed geologists walking the streets, but also result in oil fields remaining prospects and geological talent going unrecognized. Though this may be near tragedy for the unemployed geologist or the hungry consultant who cannot sell his prospect, it also affects pay raises and promotions for the company geologist and the quality of students trained by professors.

Communication barriers arise with geologists for several inherent reasons. Geologists' training is largely scientific and, as rugged individuals, they tend to feel that their professional competence will carry their ideas. Being human, they blame: (1) management, who supposedly are too far from the problem to understand the geology; (2) investors or clients, who see only dollars and not the geology; or (3) other departments who cannot understand or be bothered with scientific geologic data. The average geologist does not make the effort to recognize the problem, study it, and attempt to correct it.

Geologists obviously exercise little control on clients, the public, other departments, or management. The solution must come from within the individual himself. The sales profession studies communication more than geologists do structure, stratigraphy, or oil finding. Their simple formula results in billions of dollars in profits and commissions:

1. Sell yourself—on what the proposition can do for you and your client;
2. Know your "stuff"—your product and your client;
3. Tell your story—get his attention; speak his language; show his gain; appeal to all five senses;
4. Prepare for all possible objections and have a ready explanation for each; and
5. "Clinch" the sale.

Geologists need not attempt "silver-tongued," high-pressure salesmanship, but a similar approach will improve geological communication at all levels. The following items are my approach to the problem:

1. Know the goals—of your company or your client;
2. Strive for good ideas—they communicate better than poor ones;
3. Improve your communication mechanics—understand vocabulary, use meaningful illustrations, and organize any presentation emphasizing salient points;
4. Know the weak points and alternate solutions, and
5. *Try* to communicate.

The Toastmasters organization, though commonly considered to be only preparation for public speaking, actually trains a man to organize his thoughts and present them clearly with poise and enthusiasm in any communication situation.

The above approach should enable geologists to perforate or bend, if not shatter, communication barriers.

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LOWER CRETACEOUS OF MONTANA, NORTH DAKOTA, AND CANADA

(No abstract submitted)

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TERTIARY FORT UNION FORMATION OF NORTHERN ROCKIES

The Tertiary Fort Union Formation of Paleocene age has yielded oil and gas fields of major significance in the northern Rocky Mountain area during the past few years. Notably, the LaBarge platform area on the west flank of the Green River basin in Wyoming is the "classic" example of productivity and an excellent subject area for stratigraphic and environmental study of the Paleocene. As of January 1, 1967, the fields on the platform had a cumulative production in excess of 43 million bbls of oil and 770 Bcf of gas, produced primarily from sandstones in the Fort Union Formation.

After the uplift and erosion of the Late Cretaceous Lance Formation in the platform area, Laramide orogenic movements began with gentle uplift and truncation which cut into the Cretaceous Hilliard Formation and established an unconformity surface which subsequently was folded in response to Laramide adjustments. Following these events, general Tertiary deposition began with the formation of coaly swamps. In the steeper synclinal parts of the Green River and other intermontane basins, large bodies of water developed and thick sequences of source-bed shales filled these troughs which approached marine conditions as inland seas. The significant Fort Union production that has been found to date in the northern Rockies is associated with a beach-type environment developed along the shorelines of these inland seas. Toward the end of the time of deposition of the Fort Union, these seas were filled with sediment and only the coaly sequence remained until additional orogenic movement folded and eroded these beds—in some places as deep as the older Fort Union-sea units. The Wasatch Formation of Eocene age was deposited on this unconformity surface.

The depositional and producing environment of the Fort Union in the LaBarge platform area is not unique to the Green River basin of Wyoming. Similar conditions are evident in many other basins in the northern Rocky Mountains where little or no exploratory effort has been made to locate lucrative production similar to that found and continuing to be developed in the Green River basin.

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PENNSYLVANIAN GEOLOGY OF WESTERN MID-CONTINENT

Pennsylvanian sediments deposited between the Sierra Grande—Frontrangia positive elements and the Central Kansas uplift–Nemaha ridge trend contain large amounts of hydrocarbons. In the Anadarko basin alone almost 2 billion bbl of oil, more than 20 trillion cu ft of gas, and up to 700 million bbl of gas liquids eventually will be recovered from Pennsylvanian reservoirs. Mocane—Laverne, Camrick, Hansford, Greenwood, Keyes, and Elk City are six major Pennsylvanian fields in the western Anadarko basin. They have up to 2 billion equivalent bbls of recoverable oil in traps ranging from anticlines to purely stratigraphic. The reservoirs range from carbonate banks to alluvial sandstone and are of Morrowan to Virgilian ages.

The Anadarko and Denver basins always have been considered to be separate geologic provinces. However, during Pennsylvanian time they were part of the same geological regimen and properly should be considered together. The Amarillo-Wichita Mountains, Sierra Grande uplift and Frontrangia comprise a tectonic rim with a common orogenic history during the Pennsylvanian. The distribution of facies and depositional environments from this rim toward the stable-shelf area is similar and closely related across a broad area covering eastern Colorado, western Kansas, western Oklahoma, and parts of Nebraska, Wyoming, and Texas.

Only the Anadarko basin part of this large area has been explored actively and most of eastern Colorado and western Kansas remains a relatively virgin area for Paleozoic exploration. Because the relations of facies and environments in the whole area are similar, because the basin structure and geologic history are closely related, and because the Anadarko basin has been the scene of prolific discoveries, it could follow that the Pennsylvanian potential of the relatively unexplored area of western Kansas and eastern Colorado is very good.

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GEOLOGY OF CANADIAN HEAVY OIL SANDS

Obvious barriers that have been or could be broken by western Canadian heavy oil are in the fields of exploitation, transportation, and marketing. A geological barrier to be broken is the problem of the origin of the oil. The heavy oils appear to be at or very near the site where a discrete oil phase first was formed. An understanding of the origin of these vast accumulations of heavy oil conceivably would supply important clues to the origin of light crude oil, condensate, and gas.

There are about 750 billion bbl of heavy oil in place in western Canada and most of this occurs in sandstones of the Lower Cretaceous Mannville Group.