Frequent and rapid display of data by computer maps and tabulations can provide continuous access to every part of the data file during the life of the project. The variety of computer output can pinpoint areas in need of greater effort. Judicious use of a computer program library can provide a geologist access to most of the standard treatments. Their use may provide him with answers, but can also suggest new approaches. In many cases he may consider output from a computer model as an "unbias view" of his data.

Mathematical analyses, engineering techniques, and economic evaluations used variously by geologists become standard tools on the computer. Although their use requires his appreciation of their capabilities, and their results demand an awareness of their exploration implications, their intricacies of solution no longer concern him. Their repeated use with multiple sets of data can communicate relationships not previously known.

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PERMIAN SYSTEM OF SOUTHERN ROCKY MOUNTAINS AND SURROUNDING PROVINCES

The Permian Period lasted approximately 50 m.y., beginning 275 m.y. ago. The sedimentary rocks of this system have been divided into four series in the western United States. Despite the scarcity of datable fossils, series correlations generally are reliable except in the piedmont and intermontane redbed facies.

The basal Wolfcamp Series is more extensive and thicker, on the average, than any of the other series. The Ochoa Series, the youngest, essentially is confined to the Permian basin, the Anadarko-Hugoton area and the Great Basin. The Guadalupe Series extends well beyond the erosional limits of the underlying Leonard Series in the northern Great Plains but is absent on much of the Colorado Plateau where the Leonard is well preserved.

A regional unconformity, usually of low angle, separates Permian rocks from the Pennsylvanian System, even where the Virgil Series of Late Pennsylvanian age underlies the Wolfcamp. It is believed that late Virgilian-early Wolfcampian time is not represented in most of the region. The Triassic System also is separated from the Permian by a regional low-angle unconformity. Rocks of Early Triassic age are missing by nondeposition or erosion in part or all of the southern structural provinces where the Ochoa is present.

Detailed studies also indicate the presence of interseries unconformities of regional extent. Lower Leonard, lower Guadalupe, and lower Ochoa rocks have limited areal distribution.

Permian depositional environments ranged from terrestrial-piedmont to deep-marine-basinal. Shelf-marine carbonates generally decrease in importance upward through the system whereas evaporite deposits, including halite, are more common and more widespread.

Permian rocks are the source of considerable mineral wealth including, in addition to petroleum, potash, phosphate, sulfur, and helium. Carbonate and sandstone reservoir rocks of Guadalupian, Leonardian, and Wolfcampian ages have yielded vast quantities of oil and gas, especially in the central Rockies, Great Plains, and Permian basin. Permian source shales in western Wyoming and in the Permian basin were major oil contributors.

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CAMBRIAN HISTORY OF WESTERN UNITED STATES

The Cambrian deposits of the western United States represent three major coexisting lithofacies, arranged more or less parallel with the western margin of the continental interior. The inner lithofacies is composed largely of terrigenous materials derived from the continental interior. The middle lithofacies consists largely of clean carbonate sediments of many kinds that represent relatively shallow, commonly high-energy deposits interpreted to be the products of a great series of coalescing banks. Seaward from the carbonate belt is an outer lithofacies represented by generally dark-colored, apparently deeper water sediments containing a moderate to high proportion of siliceous materials, some of apparent terrigenous origin. Region-wide expansion and contraction of the clean carbonate environment, and overall temporal transgression of all environments toward the continental axis, have produced the complex of formations and formational sequences presently observed in the western United States.

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REGIONAL ORDOVICIAN STRATIGRAPHY OF ROCKY MOUNTAIN REGION

The Ordovician formations of the Rocky Mountain region exhibit a remarkable unity in their stratigraphic development. A formational terminology in one area serves equally well in other areas, so that the most thoroughly documented stratigraphic relationships, such as those of the Bighorn and Winnipeg Formations, can be adopted as standards for the entire Rocky Mountain province. In explanation of this procedure, regional lithological similarities within formations and lithological contrasts between each formation are illustrated to show their relation to superpositionally significant unconformities. Existing zone and stage designations not based on adequate stratigraphic integration conflict with this scheme. The Bighorn cannot be entirely Richmondian, nor can the Winnipeg be Trentonian to Chazyan if the superpositional aspect of stratigraphy is admitted as evidence for their derivation.

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JURASSIC AND TRIASSIC OF WYOMING AND SOUTHERN ROCKIES

Correlations of continental Triassic and marine Jurassic rocks in Wyoming, northwestern Colorado, and northeastern Utah are based on 150 measured sections. In central Wyoming, these rocks are about 1,000 ft thick and consist, from bottom to top, of the following formations: Crow Mountain and Popo Agie (Triassic), Nugget (Triassic? and Jurassic?), and Gypsum Spring and Sundance (Jurassic). The lower part of the Nugget has been named. South and east of the Wind River basin, rocks equivalent to the Crow Mountain are called the Jelm Formation. In northwestern Colorado and northeastern Utah, Jurassic and Triassic rocks discussed here are about 1,500 ft thick and consist, from bottom to top, of the following formations: Chinle (Triassic), Glen Canyon (Triassic and Jurassic), and Carmel and Curtis (Jurassic). These formations thin southeast toward central Colorado. Near Boulder they are represented by 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: