turbed central core. Two of these features appear to be Late Cretaceous, or younger, in age and three are dated as Jurassic-Triassic.

The Red Wing Creek, North Dakota, and Viewfield, Saskatchewan, anomalies have yielded commercial oil production, the former from the central core and the latter from the outer rim. Some interesting hydrocarbon shows are indicated at the other sites and it could be argued that they have been explored inadequately.

SCHUSTER, J. ERIC, Dept. Natural Resources, Olympia, Wash.; DAVID D. BLACKWELL, Southern Methodist Univ., Dallas, Tex.; PAUL E. HAMMOND, Portland State Univ., Portland, Ore.; and MARSHALL T. HUNTTING, Consulting Geologist, Silver Creek, Wash.

Heat-Flow Studies in Steamboat Mountain–Lemei Rock Area, Skamania County, Washington

With the financial support of the National Science Foundation, the Washington State Department of Natural Resources drilled several heat-flow holes 152 m deep in the Steamboat Mountain–Lemei Rock area of Skamania County, Washington. The study area is in the southern part of Washington's Cascade Mountains between 45°54′ and 46°07′N, and 121°40′ and 121°53′ W. This area was selected for study because geologic mapping had identified a north-trending chain of late Quaternary basaltic volcanoes that had extruded a sequence of lava flows up to 600 m thick, and because the chain of volcanoes is areally coincident with a well-defined gravity low, with a minimum value of about −110 milligals.

All the Quaternary lava flows exhibit normal remanent magnetic polarity, so are probably less than 690,000 years old. Most of the flows and volcanoes appear to be younger than the Salmon Springs glaciation (35,000 to 50,000 years ago), and some are younger than Fraser glaciation (less than about 10,000 years old). One large lava flow (the Big Lava Bed) and its source cinder cone can be shown to be between 450 and 4,000 years old by their relation to dated ash and cinder deposits erupted from nearby Mount St. Helens. The young basalts lie on deformed Tertiary sedimentary and volcanic rocks. Thermal springs with low discharge and temperatures of less than 50°C are present about 20 km south of the study area.

Thermal conductivities are 3.6 ± 1.5, 2.86 to 4.2, 3.14, and 3.0 ± 0.5 millical/cm sec C° for the Tertiary volcanics, Tertiary sediments, Tertiary basalts, and Quaternary basalts, respectively. Gradients of 47.3, 51.7, and 50.7°C km and heat flows of 1.58, 1.72, and 1.83 microcal/sq cm sec, respectively, were measured in two drill holes near the east flank of the chain of volcanoes. Gradients of 44 and 45.6°C/km and heat flows of 1.24 and 1.31 microcal/sq cm sec, respectively, were measured in two holes near the axis of the chain, and one gradient of 59.7°C/km and heat flow of 1.56 microcal/sq cm sec were measured in a drill hole near the west flank of the chain. All gradients and heat flows are terrain corrected.

These heat-flow values are probably typical regional heat-flow values for the Cascade Mountains. The data show that there is no large heat-source body within the general area of the heat-flow study. However, there is only one location in Washington, also in the Cascade Mountains, where higher gradients have been measured.

SCOTT, G. L., North American Exploration Co., Inc., Denver, Colo.

Stretching the Seismic Dollar

The primary purpose in presenting this paper is to emphasize that in seismic prospecting one must be able to arrive at a logical answer using the least expensive, reliable method for defining seismic prospects. A discussion of the history of seismic prospecting, use of previously recorded seismic data, with a summary of advanced seismic techniques will be given.

Many of the basins in the Rocky Mountains will be reviewed with an outline of the recommended seismic methods suited to each of these basins. I shall attempt to illustrate how the seismologist and geologist can use the seismic part of their exploration budget most effectively in each of these basins and in each new prospect or area of interest they encounter.

SEVERSON, DONALD E., Univ. North Dakota, Grand Forks, N.D.

Liquefaction of Northern Great Plains Lignites

The rationale is presented for coal liquefaction as a means of obtaining substitute sources for liquids presently derived from petroleum. The chemistry of coal liquefaction is briefly explained. Presently considered approaches to the commercialization of coal liquefaction technology are reviewed, and current status of various government-sponsored approaches reported. Adaption of this technology to Northern Great Plains lignites is discussed. The liquefaction research program of Project Lignite at the University of North Dakota is described, and projections of the work are discussed.

STARK, DAN, Bur. Land Management, Billings, Mont.

Lease of Federal Geothermal Energy—Rocky Road

The path of an application to develop geothermal energy on federal lands is often long and arduous. And, in this process, the merit of the proposal sometimes appears lost when we look at the final outcome. This short discussion is designed to inform you of and clarify those procedures covering geothermal applications between the time of filing and issuance of a lease decision. Emphasis will be placed on nonadjudicative procedures and actions which affect the ultimate lease decision.

STARKWEATHER, JACK A., Sawtooth Oil Co., Billings, Mont.

Jim Coulee–Little Wall Field, Musselshell County, Montana

An Early Pennsylvanian river system transected the central Montana area and eroded valleys or channels into the underlying Mississippian Heath and Otter formations. When each water course reached maturity its channel was filled with early Tyler age sediments such as shales, silts, porous point-bar sandstones and conglomerates. Wherever the porous sands were deposited