frequent and possibly prolonged interruptions. The cost of foreign oil appears certain to rise sharply in the years ahead and, coupled with a rapidly expanding volume of imported oil, soon will lead to an intolerable balance of payments trading deficit.

Clearly, it is imperative that the United States maintain a high degree of energy self-sufficiency. It must develop its own energy resources as rapidly as possible. The capital investment required will be enormous and the consumers of energy, both business and private, necessarily will have to pay more than in the past.

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BONNER FORMATION (PRECAMBRIAN BELT OF MONTANA) AS BRAIDED-STREAM SEQUENCE

The Bonner Formation of the Missoula Group probably represents a braided stream sequence that prograded over seamargin mud flats from southwestern Montana, northward across western Montana. In the Pioneer Mountains close to its source, the Bonner is both crossbedded, coarse grained, feldspathic sandstone (quartzite), reflecting subaqueous dunes in low flow regime, and horizontally laminated sand-supported conglomerate, representing deposition by transitional flow. Northwestward near Missoula, the Bonner is chiefly directionally crossbedded, coarse feldspathic sandstone (quartzite), representing subaqueous dunes. Farther northwestward, near Superior, the Bonner is mostly horizontally laminated, fine to medium feldspathic sandstone with common directionally oriented, ripple-drift cross laminae and sparse crossbeds. Here the Bonner was deposited by transition flow so shallow that upon slowing to lower regime, the bed forms altered to ripples, not dunes. Here, the Bonner also contains oscillation-rippled, mudcracked argillite and a few stromatolite beds, indicating mudflat deposition.

By integrating these areas, one can interpret the Bonner to have been a giant pediplain or fan traversed by braided streams that were large enough near their sources to carry small cobbles in transition flow. Near Missoula, the streams were carrying mostly coarse sand in a lower flow regime and probably were dispersing across the pediplain. By the time they reached the vicinity of Superior, the braided streams were very shallow and were carrying medium to mostly fine sand, and were interdigitating with extensive mud flats bordering a sea. The wedge of Bonner may reflect renewed movement in the late Precambrian along the Willow Creek fault zone.

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SOMETHING NEW IN EXPLORATION

Hydrocarbons are daily becoming more difficult to locate in the subsurface. The future major discoveries will most likely come from stratigraphic traps, and one of the most valuable stratigraphic tools is gathering dust in almost everyone's files. This stratigraphic tool is the well log. With massive, inexpensive, well-log digitization capabilities and computer software for analysis of data from these logs, the routine, expensive, time-consuming work can be reduced drastically and permit the geologist to do more creative exploration. Results from the computer analysis of digital logs from many wells have developed leads for exploration trends, have located possible bypassed hydrocarbon-bearing zones, and have indicated better productive zones within a well.

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STRATIGRAPHIC EVIDENCE FOR TIMING AND NATURE OF LATE CENOZOIC DEFORMATION IN LOS ANGELES REGION, CALIFORNIA

Stratigraphic evidence suggests that the complex pattern of basins, uplifts, and major faults in southern California has resulted from three successive episodes of late Cenozoic deformation: middle Miocene, Miocene-Pliocene, and Pasadenan.

Surface exposures rimming the southeast Los Angeles basin record a middle Miocene phase of major block faulting on northwest- and north-trending faults; related widespread volcanism implies crustal extension. In late Miocene and earliest Pliocene times, the east-west-trending Transverse Range deformation dominated the northern Los Angeles basin. En echelon, northeasterly sinistral faults may have been the precursors of the east-west Santa Monica fault system, on which 6-8 mi of sinistral Miocene-Pliocene offset has occurred.

Major Pasadenan deformation, involving dextral offset on northwest-trending faults, and reverse faulting on elements of the Transverse Range system, began in late Pliocene time in the Los Angeles region and is continuing. In the Baldwin Hills, continuous deep-water sedimentation into mid-Pleistocene time has recorded several pulses of Pasadenan deformation. Latest Pliocene folding, which developed more than 2,000 ft of structural relief on the Inglewood anticline, was followed by dextral faulting which transected the anticline. Lateral displacement has totaled about 4,000 ft and has been accompanied by formation of an upthrust block on the northeast flank and a graben across the axis. During the past 30,000 years, uplift in this seismically active area has proceeded at 10 times the average Pleistocene rate.

In the late Cenozoic deep-water basins of California, detailed stratigraphic studies of deformation history are essential in testing alternative orogenic hypotheses, both in oil exploration and in the evaluation of fault hazards.

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CALIFORNIA OIL BASINS AND IMPINGEMENT OF EAST PACIFIC RISE AGAINST NORTH AMERICA

The East Pacific Rise reached California 24-29 m.y. ago north of the Murray fracture zone and 18-20 m.y. ago south of it, on the basis of correlations of offshore magnetic anomalies with the Heirtzler geomagnetic time scale. This rearranged Paleogene paleogeography and established Neogene oil basins, first north, then south of the Transverse Ranges. South San Joaquin basin, central Coast Range basins, and the northern edge of the Ventura basin originated in Zemorrian-Arikareean time, 22.5-26 m.y. ago. Los Angeles basin and southern California borderland basins originated in late Saucesian time, over 15.3 m.y. ago.

Basin initiation was accompanied by volcanism, with K-Ar dates averaging 23 m.y. in central California and 15-16 m.y. in southern California. The rift basins were silled, favoring deposition of sapropelic "Monterey" shale alternating with reservoir-quality sands from adjacent highlands. High heat flow accompanying the East Pacific Rise caused early generation and accumulation of Neogene oil from these sapropelic shales, and accumulation of some and perhaps all of the oil in Paleogene reservoirs. The basins underwent almost continuous deformation because of Pacific-North American relative plate motion, resulting in early formation of anticlinal and stratigraphic traps. After disappearance of the East Pacific Rise heat source, the lithosphere cooled, increased in density, and subsided. Deformation of basins that were generally subsiding prevented uplift and breaching of many early-formed traps.

Comparable relations with the East Pacific Rise are found in several untested basins in the southern California borderland, Colorado delta and northern Gulf of California, and southern Baja California.