EARTH SCIENCES

From our reporter at the annual meeting of the Geological Society of America in Salt Lake City, Utah

The jumbled geology of the western U.S.

One of the most active concerns of geologists today is to explain the jumbled geology of the western United States in light of the new understanding of earth-forming processes brought about by the theory of plate tectonics.

Typical of the problem is the very young block-faulted geology of Nevada, western Utah and southern Arizona. This so-called Basin and Range structure is characterized by alternating elongated mountain ranges separated by alluviated basins. East-west stretching of the earth's crust by 50 to 100 kilometers across Nevada and western Utah is necessary to form the observed structure.

Current theories to explain the origin of the Basin and Range structure fall into three groups, as outlined by John H. Stewart of the U.S. Geological Survey at Menlo Park, Calif. Perhaps the least popular theory is that the East Pacific Rise—a site of sea-floor spreading—extends northward beneath part of North America and is causing crustal extension in Nevada. The facts don't fit this theory well. "I just wish it would die and go away," says Warren Hamilton of the USGS in Denver.

A second theory relates the structure to oblique tensional fragmentation and distributed extension initiated by collision of the North American and Pacific plates. A third theory relates spreading to an upwelling mantle diapir formed behind an active subduction plate (back arc-spreading) during a time of slackening compression after destruction of the subducting plate. Stewart believes the back arc-spreading concept is at least partly responsible. The north-south movement along the San Andreas transform fault releases pressure far inland and allows crustal spreading.

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The intriguing realization that volcanic rocks along the Snake River Plain become increasingly younger in a line northeast toward Yellowstone has caused speculation that they are the 17-million-year trace of the continental plate moving over a hot mantle plume that is now beneath Yellowstone (SN: 8/17/74, p. 105). But the idea of a mantle plume hot spot is contradicted by the decreasing age of similar rocks in a line advancing northwest across Oregon, and so the concept seems to have few defenders. Actually there are four such lines of activity radiating from a point near Twin Falls, Idaho. Robert B. Smith of the University of Utah believes these lines delineate separate subplates of the North American crustal plate. He and Harold J. Prostka and Steven S. Oriel of the USGS at Denver believe the segments may reflect the spread of a broad, rising mantle diapir beneath Twin Falls, causing high heat flow, crustal extension and seismicity.

When the Colorado flowed northwest

The mighty Colorado River flows through canyons cut deep into uplifted rock in Arizona and then heads south into the Gulf of California. But it wasn't always that way. Some 18 million years ago northern Arizona was an area of gentle landscape at only a moderate elevation above sea level. Studies of the history of the river's tributaries, combined with carbon dating, have now answered part of the question of where the Colorado flowed. It appears that 18 million years ago the river flowed northwest out the northwestern corner of Arizona across the southwestern tip of Utah, possibly near the present town of St. George, Utah, according to Eugene M. Shoemaker of the U.S. Geological Survey at Flagstaff. Shoemaker says it then undoubtedly flowed across Nevada and California and into the Pacific. Field teams have been looking for gravel of the former river bed in the St. George area. "Chances are the river bed is preserved somewhere under a lava flow," Shoemaker says. "We'd dearly love to find it."

Later the Colorado Plateau began uplifting, and about five million years ago came a moment of major drainage capture. Faulting and uplift blocked the river's northwest passage. The drainage was suddenly diverted, and the waters poured over the Grand Wash Cliffs and headed west and south to the then newly opening Gulf of California.

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The history of the Colorado River drainage system is part of a larger problem of the uplift of the Colorado Plateau to its mile-above-sea-level elevation. Shoemaker contends that most of the uplift was completed in Miocene times, by about five million years ago. He disagrees with evidence by W. Kenneth Hamblin, a Brigham Young University geologist, that uplift is still continuing today. Shoemaker considers the uplift to be caused by thermal expansion in the mantle.

Space-borne sightings of astroblemes

Well-formed craters on earth caused by meteorite impact may be easy enough to identify. Far more of a challenge is the detection of astroblemes, scars in solid surface rock caused by meteorite impact in the earth's ancient past. A number of astroblemes are known, and some of them are huge.

Imagery from the Landsat satellite offers a new look at craters and astroblemes. John F. McHone Jr. of the University of Illinois and Robert S. Dietz of the National Oceanic and Atmospheric Administration have compiled an atlas of known impact sites from such images and, by comparison, selected other geologic features of possible extraterrestrial origin.

They report that the satellite imagery has detected at least two previously unknown astroblemes. One, in the Arabian Peninsula, has been named the Oman Ring. This ghost-ring structure is six kilometers in diameter with a two-kilometer-wide central dome. Another probable site is in northeastern Siberia, called Ozero El'gygytgyn. The location, a crater lake 14 km across, resembles New Quebec crater in Canada but is much larger and more maturely eroded. Imagery shows the roughly circular shore line to be enclosed by highly circular geomorphology. McHone and Dietz say the feature was probably caused by impact of a meteorite in the early Quaternary or late Pliocene.

Quarry-caused earthquake

An earthquake on June 7, 1974, at Wappingers Falls, N.Y., appears to have been caused by human activity. The quake, of magnitude 3.3, was followed in the next six days by more than 100 aftershocks, 42 of which were recorded at enough seismic stations to be accurately located.

The aftershocks occurred within or beneath a block of dolomitic limestone that has been extensively quarried. Their focal depths varied from 0 to 1½ km. Paul W. Pomeroy of the New York State Geological Survey and David W. Simpson and Marc L. Sbar of the Lamont-Doherty Geological Observatory have studied the data. They conclude that "all of the available evidence, including locations, the composite fault plane solution and energy considerations, indicate that this earthquake sequence and possibly past earthquakes in the same area have been triggered by crustal unloading associated with quarrying operations."