Earth Sciences

Rifts break through the weak spots

The water-etched lower boundaries of Saudi Arabia — the Gulf of Suez on the west and the Gulf of Aqaba on the east — illustrate how rifts in the upper earth tend to follow the path of least resistance, traveling through the weakest areas, according to Michael S. Steckler and Uri S. ten Brink of the Lamont-Doherty Geological Observatory in Palisades, N.Y.

In a paper to be published in EARTH AND PLANETARY SCIENCE LETTERS, the two geophysicists state that rifts underlying both the Suez and Aqaba were formed by the same movement between the African and Arabian plates. The Suez rift formed first, propagating northwestward from the Red Sea until about 17 million years ago, when it reached the Mediterranean Ocean, where the lithosphere (the upper 100 kilometers of crust and upper mantle) is much stronger than under the African continent. At this Mediterranean barrier, the Suez rift slowed almost to a halt, and a new rift opened from the Red Sea northeastward, Steckler says. This one, running through the Gulf of Aqaba and farther north through the Dead Sea, continues today, Steckler says, and is likely someday to split the African and Arabian continents apart.

The lithosphere under continents is mostly weaker than that under oceans because it is made up of a thicker portion of crust and a correspondingly thinner portion of mantle, Steckler explains. Continental lithosphere is strongest in midcontinent areas, where it is oldest and therefore coldest. It is warmest, and weakest, at the edges, Steckler says.

This explains why so many of the world's fault zones skirt the edges of continents, Steckler says. The Aqaba rift, for example, runs along the weakest zone on the eastern edge of the African continent. Similarly, the San Andreas fault slices along the western edge of California, and the Fairweather and Queen Charlotte faults trim the edges of Canada and Alaska.

Fossilized magnets and fickle rocks

As the Pacific Ocean floor spread 65 million to 118 million years ago, magma from the earth's upper mantle rose to the surface to form unusually large numbers of seamounts similar to the Hawaiian Islands. The cooling lava took on the prevailing magnetic polarity of the earth.

This phenomenon is important to geologists, who use the fossilized magnetism of Pacific seamounts to deduce the movement of the Pacific plate and to understand global tectonics. This method is sometimes inaccurate, though, for two reasons: Moving plates carried seamounts into areas of different magnetic alignment, and the earth's magnetic poles have flip-flopped from north to south about every half-million years. As a result, an unknown portion of the magmatic rock gradually changed to realign itself with the prevailing magnetic direction, jeopardizing geologists' ability to chart plate movement.

Two researchers at the Scripps Institution of Oceanography in La Jolla, Calif., have found a way to use the magnetic polarity of seamounts more accurately. John Hildebrand and Hubert Staudigel studied Pacific seamounts with normal and reversed polarity. They found that, while most of the seamounts' magnetization remained stable throughout the changes in magnetic polarity, 25 percent of the magnetization changed. According to Staudigel, this change could be caused either by slowly changing magnetization or by quickly changing magnetization that changes with the prevailing magnetic field. Although researchers cannot distinguish between the two types from field observations, the total amount is relatively small when compared with a third type of magnetization that maintains the polarity of its formation.

This finding, says Staudigel, means researchers can still use ancient traces of magnetism in seamounts to accurately track the movement of plates in the Pacific basin.

Space Sciences

Shuttle-Centaur canceled

Even as NASA grapples with the task of getting the space shuttle flying again, safety concerns have prompted the agency to cancel plans for launching shuttle-deployed spacecraft with a powerful upper-stage rocket that had been developed specifically for the purpose — and on which $674 million had already been spent. Called the Centaur, the rocket uses the same volatile liquid-hydrogen and liquid-oxygen propellants that fuel the shuttle's own main engines, and which destroyed the shuttlecraft Challenger when they exploded on Jan. 28.

The shuttle version of the Centaur is a variation on one that has been in use for a decade atop unmanned, expendable rockets for such tasks as sending the Viking spacecraft to Mars. Its first uses from the shuttle were to have been in May, when Centaurs were to have launched the Galileo orbiter-and-probe mission to Jupiter and the European Space Agency's Ulysses mission on a course that would swing around Jupiter on the way to a flight over the poles of the sun. Other shuttle-lofted Centaurs were planned for a U.S. Venus-radar-mapping spacecraft called Galileo, now under construction, as well as for several payloads for the Department of Defense.

Banning the Centaur from the shuttle has not caused the cancellation of any of these missions, but it requires adopting other ways to launch them. Even before the shuttle explosion, the Air Force was laying plans for a backup system, ordering a variation of its own unmanned Titan 34D7 rocket that could carry the Centaur as an upper-stage. Ten of them are already on order, and the Air Force hopes to get more. As for NASA, the agency is now studying a variety of options, including the use of Titan rockets with the Centaur, as well as of the shuttle itself but with a different upper-stage that is fueled by solid propellants instead of the touchy hydrogen/oxygen mixture. Possibilities under study include modifications of the Air Force's existing Inertial Upper Stage booster, as well as a commercial booster called the Transfer Orbit Stage, being developed by Orbital Sciences Corp. in Vienna, Va.

A number of people had voiced safety concerns about the shuttle-Centaur even before the rocket got the development go-ahead in 1981, but NASA concluded at the time that the safety margin was adequate. The issue arose again after the shuttle explosion, however, prompting investigation in an independent study by the surveys and investigation staff of the House subcommittee that deals with NASA appropriations. Among the safety issues raised was the possibility that if a space shuttle carrying a Centaur had to abort its mission and make an emergency landing, it would be necessary first to dump the Centaur propellants overboard — through valves that had shown reliability problems in recent testing.

"Although the shuttle-Centaur decision was very difficult to make," says NASA Administrator James C. Fletcher, "it is the proper thing to do and this is the time to do it."

NASA resumes testing shuttle engines

In a landmark of sorts as NASA attempts to recover from the wide-ranging effects of the Challenger explosion, the agency on June 25 test-fired a space shuttle engine for the first time since the disaster. Conducted at the National Space Technology Laboratories (NSTL) in Bay St. Louis, Mo., the test lasted only 1.5 seconds, primarily as a check of the engine and its components on the test stand in preparation for a 250-second firing expected to take place within the next two weeks. All shuttle engines are ground-tested before they are used in a launching, and NSTL has been conducting such tests since 1975, six years before the shuttle first blasted off. Although there had been no layoffs since the accident, says an NSTL official, the brief firing symbolized a "return to normalcy." The test itself, says the official, went "just fine."