MOUNTAIN BUILDING

Shaping the Alps

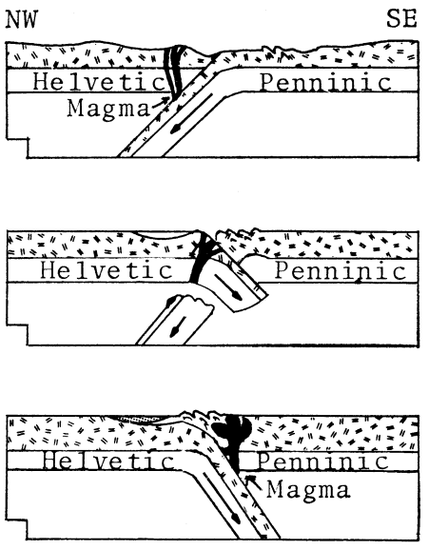
The crustal plates that slide around on the surface of the earth seem to be capable of many complex maneuvers and transformations. In the Aleutians, for example, a plate source became instead a site of plate destruction (SN: 2/27/71, p. 150). In 1969 Dr. D. P. McKenzie of Cambridge University first illustrated the mechanism of plate flipping, in which an overriding plate becomes an underthrusting plate. Drs. K. J. Hsü of the Swiss Federal Institute of Technology and S. O. Schlanger of the University of California at Riverside believe that such a flip may have influenced the shape of the Alps. The clues to a possible flip lie in the widespread deposits of sandstones, shales and clays, called Flysch, that border the Alps.

The origin of these deposits has been the subject of many papers. Reconstructions of the original relative positions of the shelf lying west of the Rhine and north of the Alps indicate that it once bulged toward the southeast. This bulge, suggest Drs. Hsü and Schlanger, may once have been bordered on the southeast by a parallel basin, island arc and trench system. The Flysch sediments, which lie among the lesser Alps to the southeast of the shelf, could then be explained as ocean basin deposits associated with the arc.

However, if the island arc explanation is correct, and if the arc is compared with similar arcs now existing, the trench must have been the site of underthrusting, with a northward-moving plate descending as the Flysch was deposited. Yet evidence in the Alps indicates that, after deposition of the Flysch, the southward-moving plate was the one that was descending. Further, the Alps themselves curve convexly to the north, in a direction opposite to that of the proposed island arc system. A flip in plate motions, the scientists suggest in the May GEOLOGICAL SOCIETY OF AMERICA BULLETIN, could account for the conflicting curvatures.

During the Paleocene (58 million to 65 million years ago), they say, an island arc, with a basin to the north and a trench to the south, lay south of the shelf. South of the trench was a submarine ridge, and still farther south a sea-floor plain. The present-day Hellenic Arc in the eastern Mediterranean, they point out, is very similar to their proposed arrangement, and can be considered as a modern model.

A thin crustal plate, the Penninic plate, was moving northwestward and descending below a thicker northern plate—the Helvetic plate—at the trench. Eventually, the plate movements



Adapted by E. Cherry Doyle

Plate flipping: An exchange of roles.

caused large bodies of rock to accumulate southeast of the plate junction, thickening the Penninic plate. About 45 million years ago, Drs. Hsü and Schlanger believe, a flip occurred, and the thickened Penninic plate began to override the Helvetic plate. The crustal material that had accumulated south of the trench was stripped off by the descending Helvetic plate and pushed northward to its present position. This flip in plate motions, Drs. Hsü and Schlanger say, resulted in a reversal of the curvature of the developing Alps.

Geological evidence in the present-day Alps seems to confirm their model. A granite intrusion about 35 million years old lies above the point where the Helvetic plate, descending at an angle of 45 degrees, would have begun to melt. Moving at a rate of two centimeters per year, the leading edge of the plate would have reached this point about 38 million years ago. □

NEW TECHNIQUES

Controlling pain at the gate

The gate threshold theory of pain (SN: 6/12/71, p. 400), proposed by Drs. Patrick Wall of London and Ronald Melzack of Montreal in 1965, has served as the basis for the development of two new techniques for the control of pain. The procedures are dorsal column stimulation and saline injection.

Dr. Norman Shealey of La Crosse, Wis., initiated dorsal column stimulation in 1968. Dr. Edward Hitchcock of Edinburgh began using the saline injection in 1967. The former technique is being practiced by a select number of American neurosurgeons, among them Dr. Glenn Meyer of the University of Texas at Galveston. Saline injection is being tried by a few neurosurgeons and several anesthesiologists. Dr. Meyer reported on both techniques at the annual convention of the American Medical Association last week.

The gate threshold theory holds that physical pain sensations are integrated in the dorsal gray matter of the spinal cord before they reach the brain. Small dorsal root fibers open the pain gate and larger root fibers close the gate. The two pain techniques work at opposite ends of this theory. Dorsal column aids the gate-closer by stimulating the large dorsal root fibers; saline injection battles the gate-opener by destroying small fibers.

The dorsal technique calls for attaching electrodes and receiving antenna to the dura mater, the tough membrane enclosing the spinal cord. The implantation could be performed under a local anesthetic, but Dr. Meyer says it is generally conducted under general anesthesia. The patient is then given a "pain control box" about the size of a cigarette package, which sends out radio waves to the antenna in the patient's dura mater, and they in turn stimulate the implanted electrodes. The patient can turn the box on whenever he's in pain.

Saline injection consists of injecting saline solution into the spinal fluid that bathes the dorsal roots and spinal cord. The solution must have a greater concentration of ions than blood serum does to destroy small dorsal root fibers. This procedure is performed under general anesthesia.

Both techniques have been tried on patients with pain for which there is no definitive cure, such as cancer, spinal disk failure or phantom-limb pain from arm or leg amputation. There have been an ample number of successes: 55 out of 95 dorsal stimulation cases performed by ten investigators and followed up by Dr. Shealey and some 50 percent of 126 saline injections performed by eight investigators and followed up by Dr. Meyer. Dorsal stimulation brought pain relief for four months to two years; the saline injection, for three months or longer.

But both techniques have obviously failed in a fair number of patients. Dr. Meyer believes the failures might be attributed to pain being a psychological as well as a physical experience. If pain is primarily in the psyche and not a physical sensation, he says, the technique will understandably have limited success.

Before using either dorsal stimulation or saline injection, Dr. Meyer cautions, the physician must weigh the risks of the procedures against the long-range side-effects of aspirin, narcotics and other pain drugs. Most physicians are withholding judgment on the techniques until more clinical experience with them accumulates. □