The Moho is immutable no more

For decades, geoscientists have thought of the Moho as a simple, immutable dividing line between the earth's crust and mantle. Discovered in 1909 by Yugoslavian seismologist Andrija Mohorovičić, the continental Moho resides at depths of 35 kilometers, where the speeds of seismic waves traveling through the earth abruptly change.

In recent years, high-quality seismic reflection profiling — in which sound waves sent into the crust bounce back off contrasting rock types (SN: 12/8/84, p.364) — has provided seismologists with a much closer look at the Moho. And they are beginning to see that it has a more complex structure than once thought. This is leading them to wonder exactly what the Moho is, how it is formed and whether it changes with time.

Some of the latest seismic reflection profiles illustrating the puzzling character of the Moho were displayed last week at the meeting of the Geological Society of America in San Antonio, Tex. The data were compiled by the Consortium for Continental Reflection Profiling (COCORP), one of several research groups in the world doing systematic seismic surveys of the crust. COCORP members discussed some of the more than 2,500 kilometers of new seismic lines taken across the northwest Cordillera, the southern Appalachians and the U.S. Basin and Range Province.

One surprising aspect is evident in the Cordilleran mountain belt, which extends from Alaska to Guatemala. Its northwestern section is a patchwork of different crustal fragments that were carried thousands of kilometers by plate motion and jammed into the North American continent. Yet in profiles of the northwestern Cordillera, the Moho shows up as a flat, bright reflection that extends continuously through this region, oblivious to the sutures and different geologic boundaries that are so evident at the surface. Moreover, in some areas of this region, reflection profiles show that fault-like structures dip into the crust but are cut off at the Moho.

"This all implies that the Moho is a young structure," having re-formed after the terrains were plastered on to the continent, says K. Douglas Nelson of COCORP, which is headquartered at Cornell University. Something has made the Moho straight and continuous, erasing the bottoms of older faults and other geologic boundaries; the new Moho was superimposed on the older crustal fabric.

Some sort of change in the Moho's structure is apparent also in comparisons between the Cordillera and younger mountain belts, such as the Himalayas. There, the Moho is discontinuous, jumping to different depths in different regions. How, asks Nelson, does the Moho structure beneath the Himalayas change to that under the Cordillera? What changed the shape and character of the crust?

One possibility is that the newer, continuous Mohos were created — replacing old ones — when the crust was stretched out. In addition to the northwestern Cordillera, sharp, flat and highly reflective Mohos are seen in the Basin and Range Province, the continental shelf around Great Britain, the Paris basin and the U.S. Atlantic shelf. In most of these places, the last known major tectonic event was crustal extension. Perhaps in this process the crustal fabric was smoothed out, thinned and aligned horizontally. Another suggestion, according to Nelson, is that intrusions of magma into the lower crust left horizontal layers that differ in chemical makeup from surrounding rocks.

While the Moho is clearly defined in seismic profiles of these extensional regions, it is much more diffuse in other areas, such as the North American craton — one of the oldest, nonmountainous, "undeformable" parts of the continent. For example, such diffuse Mohos show up in COCORP profiles of flat regions such as Kansas, Minnesota, Wyoming and the Colorado plateau.

"Many geologists have the perception that the processes that made mountain belts in recent times are basically the same processes that made the crust back through the Precambrian," says Nelson. "If that's true, then Precambrian crust in

Balloon use helps heart valves

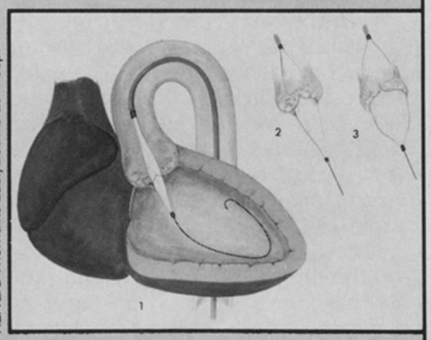
Balloons, first used in hearts to open up narrowed blood vessels, can also free up stiffened heart valves, according to several studies presented this week in Dallas at the American Heart Association meeting. The procedure, known as balloon valvuloplasty, was first done in 1979 in children with congenital valve disease; its more recent application to adults represents a significant broadening of its horizons.

In addition to congenital causes, rheumatic fever and the general aging process can cause valve disease. The four valves in the heart, each several leaves of delicate tissue that jointly open in only one direction, keep blood headed the right way. Calcification of the valves partially fuses the flaps together. Malfunctioning valves can ultimately be deadly.

At the meeting, researchers from Asia, South America, Europe and the United States described positive results in trials of balloon valvuloplasty in dozens of adults. While techniques vary, the basic procedure, first done in adults in 1984, is to thread a balloon through a catheter into a sticky valve while the heart is beating. The balloon is then inflated for up to 40 seconds using a saline/dye solution, at a pressure of 45 to 60 pounds per square inch. The inflation splits the flaps of the valve apart, allowing them to open and close more freely.

William Grossman and his co-workers at Harvard Medical School have done balloon valvuloplasty on 76 people since October 1985. "Results in general have been quite good," he says. Grossman says the two who died within a week succumbed to preexisting damage, not to the valvuloplasty itself.

The current treatment for people with diseased heart valves is either to replace or to surgically slice apart the valve flaps. Tens of thousands of such operations are done annually. But many people with diseased valves are too old or infirm to withstand the surgery. The balloon procedure can be done with painkillers and local, rather than general, anesthesia, and the patient can leave the hospital within a few days, Grossman says.



Harvard-Thorndike Lab./Beth Israel Hosp.

A balloon opens the valve that keeps blood intended for the body from flowing back into the heart. The balloon is inflated with a saline/dye solution at a pressure of 45 to 60 pounds per square inch.

He does not expect the technique to replace valve surgery, however. "This is definitely new and must be regarded as experimental," he says. People with leaky rather than stiff valves will not be helped by balloon valvuloplasty, and the procedure does not keep the opened valve from stiffening up again.

And what if the balloon bursts? It has happened, says Charles McKay of Los Angeles County/University of Southern California Medical Center, where 22 operations — some using two balloons in the same valve — have been done "with very encouraging results." But bursting hasn't been a problem — the deflated balloon is pulled out through the catheter, and the saline/dye solution flows harmlessly through the patient's bloodstream. —*J. Silberner*