abruptly increased about 4 million years ago.

Curiously, Wisdom and Touma found no such tilt transition when they excluded the effects of general relativity from their equations of motion for the planets. These gravitational effects have a subtle, but apparently significant influence on the evolution of planetary orbits in the solar system.

"Perhaps the geology of Mars will ultimately provide another test of the validity of general relativity," the researchers note.

In Earth's case, the moon's hefty mass forces Earth's spin axis to rotate, or precess, rapidly enough to forestall wildly erratic variations in Earth's tilt. Although one complete rotation of the spin axis requires about 26,000 years, that's fast enough to keep Earth out of the range of disturbing resonances with other motions in the solar system.

"If [the moon] were not present, or if it were smaller, for many values of [Earth's] primordial spin rate, the obliquity of the Earth would be chaotic with very large variations, reaching more than 50 degrees in a few million years and even, in the long term, more than 85 degrees," Laskar and his colleagues conclude.

Thus, the moon may play a crucial role in regulating Earth's climate, stabilizing it enough to permit the evolution of life, the researchers speculate. Indeed, the presence of a moon-size satellite may be a necessary condition for finding Earth-size planets with Earth-like climates in orbits around neighboring stars.

In a separate paper in the Feb. 18 NATURE, Laskar and his colleagues suggest that the tilts of all the inner planets could have evolved chaotically at various times in the past. Earth itself may even enter such a chaotic zone when the distance between Earth and a slowly departing moon shifts in 2 billion years from its present-day distance of about 60 Earth radii to 68 Earth radii. Given that variations in tilt angle as small as 2 degrees may trigger ice ages, the forecast for Earth when its axis shifts to an angle of nearly 60 degrees would certainly be bleak. — *I. Peterson*

Baldness: Heart-risk marker

Middle-aged men who lament the loss of their hair have another reason to worry: A new study links baldness with increased risk of heart attack.

Epidemiologist Samuel M. Lesko of the Boston University School of Medicine and his colleagues studied 665 men age 21 to 54 who had been admitted to one of 35 hospitals after suffering their first heart attack. The authors also looked at 772 male controls matched for age who had gone to the same hospitals but who did not suffer from heart disease.

The researchers rated each man's hair loss using a five-point scale. The team observed a higher frequency of vertex scalp baldness (hair lost from the top of the head) in the group of men who had suffered a heart attack.

Indeed, the group's statistical analysis revealed that men with top-of-the-head baldness faced a 40 percent greater risk of heart attack than men with a full head of hair. Men with the greatest vertex scalp baldness had the highest risk, Lesko says.

For men with a receding hairline, this study offers reassuring news: Men with frontal hair loss showed no increased heart attack threat, he adds.

The association between baldness and heart attacks remained after the researchers accounted for other risk factors, such as a family history of heart attack, smoking, and high blood pressure. The team published their findings in the Feb. 24 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

"Is baldness bad news for the heart?" asks an editorial written by Peter W. F. Wilson and William B. Kannel, both of the Framingham (Mass.) Heart Study. "It is premature to provide a verdict," they say. Lesko agrees, noting that additional studies must confirm the link between baldness and heart attack risk. □

Mixing Earth's mantle with a delayed flush

Journeying deep into computer versions of the Earth, two research teams independently have found evidence that could force a compromise in a divisive debate about the currents of rock flowing inside the mantle — the thick layer separating the planet's metallic core from its thin veneer of a crust. Over geologic time, these currents send Earth's continents slowly careening around the world, slamming together to form mountain ranges and rifting apart to create ocean basins.

For decades, geoscientists have argued over whether convection currents stir the entire mantle or whether the mantle is layered into upper and lower parts that do not mix. The new supercomputer simulations suggest that the real world may combine elements of both ideas, with a generally stratified mantle that occasionally flushes great masses of rock across the boundary and down toward the core.

Although the two groups have taken different routes in creating numerical versions of the mantle, both sets of calculations show flushing patterns, a correspondence that lends credence to the concept. "It seems to be something that might really be happening inside the Earth," says Paul J. Tackley of the California Institute of Technology in Pasadena, a member of one of the modeling teams. Tackley and his colleagues published their findings in the Feb. 25 NATURE.

The other modeling group, led by Satoru Honda of the University of Hiroshima in Japan, discuss their simulations in the Feb. 26 SCIENCE.

Both models are three-dimensional representations of the mantle that depart from previous ones by including a critical transition at a depth of 670 kilometers — the boundary between the upper and lower mantles. Seismologists discovered the boundary when they noticed that seismic vibrations speed up when descending past 670 km. To explain the speed change, mineralogists have theorized that the transition marks a phase change: Rock below the boundary is thought to have a denser crystalline structure than rock above the boundary.

In the model simulations, as rock at the top of the mantle cools, it sinks until it reaches the 670 km boundary. Initially, the cooler, downwelling rock is not dense enough to sink into the lower mantle, so it pools right above the boundary. Eventually, however, the puddle of cooler rock grows heavy enough to break through the boundary and cascade into the lower mantle, flowing toward the core.

While the flushing pattern appears in both simulations, it takes different forms in the two models. Tackley's group found three or four breakthroughs occurring around the world at any one time. Honda and his colleagues saw the cascades developing one at a time and affecting the entire Earth. As it sinks into the lower mantle, the downflowing material would send plumes of hot material from near the core rising into the upper mantle.

The discrepancy may stem from basic differences in the models. Tackley's team uses a spherical mantle, whereas Honda's group represents the mantle as a wide fish-tank-like box.

The modeling results may help explain observations made by seismologists who study slabs of ocean floor that get pushed down into the mantle during collisions with other pieces of ocean floor or continents. In some places, the boundary at 670 km appears to deflect the slabs, preventing them from sinking into the lower mantle. In others, the slabs seem to penetrate the boundary. That pattern may match the simulations, which show flushing occurring only in limited locations, says geophysicist Scott D. King of Purdue University in West Lafayette, Ind.

While the new models show promise, everyone involved realizes that the present generation of numerical simulations lacks important elements that could alter the mantle picture considerably. Researchers are currently trying to add the effect of tectonic plates, which are much stiffer than the mantle rock. — *R. Monastersky*