This Week in SCIENCE

Crustal fluid flow

FLUID movement in the upper crust of the earth is mainly driven by two energy sources. One is solar radiation, which is responsible for the hydrologic cycle, the evaporation and precipitation of water. The other is heat from the earth's interior, which is most evident in areas where magma intrudes the upper crust: Yellowstone and the hydrothermal vents at mid-ocean ridges are well-known examples of this (and the cover photo also shows the phenomenon). Such convection and other processes associated with tectonics move water and hydrocarbons in the rock cycle. Recent studies have shown that fluid flow can occur on a large (regional) scale over long time periods: for example, water flowing in Australia's 900-kilometer-wide J aquifer traverses the basin in roughly 2 million years; groundwater from the Rocky Mountains is discharged some 1000 kilometers east in central Missouri after picking up salts and minerals from rocks in Kansas. Interactions of fluids with rocks and interactions of fluids affected by the hydrologic and rock cycles produce interesting and economically valuable resources such as tar sands (hydrocarbon accumulations) and gold and uranium deposits. The physical and chemical features of fluid circulation in the upper crust are subjects of Cathles' article (page 323), one of six that describe the dynamics of fluids on the earth and in space (pages 308 to 350). Hanson's editorial provides an overview of these articles (page 281).

Assessing earthquake hazards

LARGE intraplate earthquakes occurred in 1811 and 1812 in the New Madrid Seismic Zone, which includes parts of Missouri, Illinois, Kentucky, Tennessee, and Arkansas. Hamilton and Mooney have reevaluated data from a seismic-refraction survey that was carried out in the area in 1980 (page 351). Thirty-four explosions had been set off from nine different locations; 100 seismographs recorded the seismic waves. The directions, speeds, and strengths of the traveling seismic waves provide clues to the nature of the crust that the waves are passing through. Strong attenuation, or damping, of waves was found to correlate with active faults. (Attenuation characteristically occurs when the waves pass through regions of the crust that have fractured extensively.) The survey techniques are applicable to other intraplate seismic zones besides New Madrid (which is considered one of the most hazardous in the eastern half of the United States) and could assist in the identification of other earthquake-prone fault zones.

Vesicle stability

EXCEPTIONALLY stable artificial vesicles with potential clinical and laboratory uses can be formed by mixing together two charged surfactants with oppositely charged head groups; individually, each of the surfactants will self assemble into micelles or into stacks of bilayers but not into vesicles. Safran *et al.* propose a model based on curvature energy considerations to explain why the formation of vesicles is favored thermodynamically (page 354). Synergy between the two lipid components—involving either interactions of their polar heads or their chains—results in formation of a stable vesicle consisting of an inner and an outer monolayer; achieving the state of lowest free energy requires nonideal mixing of the surfactants. An understanding of the special stability of these vesicles could help in accounting for how membranes in biologic systems are stabilized.

Time warp in development

LARVAE of the marine mollusk *Phestilla sibogae* live among and feed on phytoplankton; juveniles and adults live on the sea bed (benthos) and feed on coral. Metamorphosis of larvae to juvenile forms occurs only after a chemical signal is received from sea corals. The chance encounter of the organism with the chemical from the benthic habitat ensures that development will only proceed when the organism is in an environment supportive of survival and reproduction. The length of the larval stage of *Phestilla* has been found to be extremely flexible: in laboratory experiments it varied from 8 to 28 days (page 356). Although the delay in metamorphosis does not affect the lengths of either the juvenile or adult stages in *Phestilla* or its reproductive success, it can significantly alter the organism's life-span. Miller and Hadfield discuss these and various other benefits to the organism of having a larval-stage developmental hiatus; they also point out possible costs, such as shrinkage of the genetic range of the local population.

Immune injury in hepatitis

LIVER damage and other disease signs in hepatitis may in part be due to immune responses that are made by the infected individual to antigens of the infecting virus (page 361). Among the pathologic responses may be those directed against a viral antigen that is found on the surface of infected liver cells. Moriyama *et al.* have used a transgenic mouse model system to demonstrate how host immune responses could contribute to disease; this system has been the only one so far in which hepatitis B infections can be studied experimentally. Mice made both antibodies (early on) and T cells (later) that reacted with viral antigen; necrosis and inflammation occurred, liver cells died, and levels of liver enzymes in the blood increased. The histologic picture in the affected mice resembled that of humans suffering from chronic hepatitis. Transgenic model systems could be of use in studies of other infectious diseases that, like hepatitis B infections, are not accessible to analysis with simpler systems.

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