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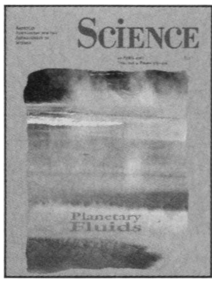

COVER The Champagne Pool, named for its CO_2 bubbles, provides an interesting window into fluid processes beneath Waiotapu, the largest area of surface thermal activity in New Zealand. The pool occupies a 900-year-old hydrothermal explosion crater. Evaporation cools the surface waters from 100°C to about 75°C, producing the steam. Amorphous silica, blown by the wind to the sides, settles as an orange coating that contains 80 parts per million of gold and 175 parts per million of silver. See page 323. [Photograph by L. M. Cathles]

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Planetary Fluids

The internal dynamics of planets, driven by various energy sources, are principally evident in the motions of fluids. The complex motions of the atmosphere and oceans are most familiar, but similar motions in Earth's outer core produce the magnetic field and convection of the mantle drives plate tectonics. Chemical interaction of fluids with the crust and mantle produces mineral deposits, petroleum resources, and volcanoes and provides nutrients for biological communities. Study of these fluids is thus central to our understanding of the workings and evolution of planets, as well as to our interaction with our own planet.

The articles in this issue of *Science* highlight recent progress in understanding the dynamics and effects of several important planetary fluids. The nature of the various research efforts and the underlying patterns observed are in many respects similar; studies differ in the ways the various fluids must be probed. Because evidence of the motions and effects of these fluids is often enigmatic or difficult to obtain, mathematical models and scaled experiments are also used to develop a more complete picture. Current research is aimed at obtaining new and better sources of data and at improving the models and experiments.

Most of the articles focus on Earth, but comparison with fluids on other planets, where conditions and energy inputs are different, is essential for a complete understanding. The planetary fluids we know best are the atmospheres, and the recent Voyager missions revealed many unusual features shared by the outer planets. Ingersoll relates these and earlier observations to the energy inputs and fluid dynamical models of atmospheric flow. The outer planets have higher wind speeds, smaller temperature differences between the equator and poles, and storms that last longer than those on Earth.

Energy ultimately derived from the sun also drives the circulation of the oceans; this motion in turn greatly affects global climate. Pedlosky shows how recent oceanographic observations and theoretical advances in treating the forcings of winds and Earth's rotation are helping to unravel the dynamics of the oceanic gyres—the large pools of swirling waters that extend to depths of up to 2 kilometers in the subtropics of each ocean.

Three articles discuss the movements and effects of aqueous and carbon- and hydrocarbon-rich fluids in Earth's crust and mantle. The interaction of crustal and mantle fluids in Earth may have caused its evolution to differ markedly from that of the other terrestrial planets, notably Venus.* Cathles describes recent evidence of voluminous and regionally extensive fluid flow in the oceanic and upper continental crust. Fluids trapped from this flow in altered oceanic crust and sediments are released to the mantle in subduction zones. Peacock estimates the amount of fluids involved and follows the evolution and fate of fluids as a function of the thermal structure of subduction zones. The oxidation state of samples of the mantle brought up by magmas or exposed in mountain belts provides a useful tracer of the interaction of such fluids with the mantle. Wood, Bryndzia, and Johnson examine the variation in oxidation state of different regions of the mantle; samples from near modern and ancient subduction zones are relatively oxidized compared with samples from mid-ocean ridges, where the formation of new oceanic crust releases mantle fluids to the oceans and atmosphere.

The tracer for the long-term fluid motions of the outer core is the record of past magnetic fields preserved in rocks; this magnetic record potentially can be extended back several billion years. Merrill and McFadden show that details of the reversals and other variations of the field are now becoming clear and are starting to provide essential data for mathematical models of the geodynamo.

On this 20th anniversary of Earth Day, there is a growing appreciation of our impact on our environment. Many of the immediate problems we confront from climate change to natural hazards are directly linked to Earth's dynamics, processes of change that have continued for more than 4 billion years; thus, progress in finding solutions may well reflect how well we understand how our planet works.—R. BROOKS HANSON

*W. M. Kaula, *Science* **247**, 1191 (1990).