X-rays record coal's dynamic meltdown

Photographs and time-lapse movies "revealing never-before-seen details" of coal's chemical breakdown under heat were presented last week in Phoenix at the meeting of the American Physical Society. These glimpses into coal gasification — documenting the melting of coal from a relatively dense solid into a porous foam —were made by Donald Maylotte and colleagues at the General Electric Co. using a computed tomography X-ray scanner — the same diagnostic tool used to visualize cross-section images of internal human-body tissues (SN: 3/13/76, p. 171).

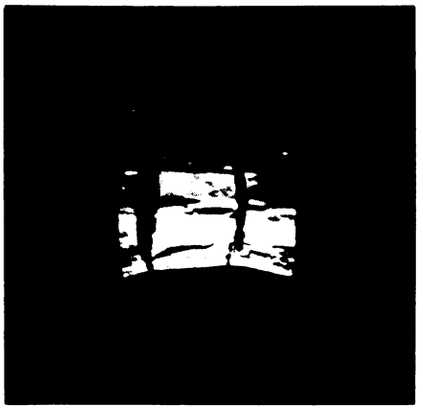
GE created a coal gasifier one foot in diameter and 26 inches long to slide into the CT scanner. Thermocouples inside the gasifier — which can reach temperatures to 1,832° F — mapped temperatures of the coal and surrounding areas. The furnace also extracted various coal-decomposition gases and piped them to a mass spectrometer where they were identified and measured.

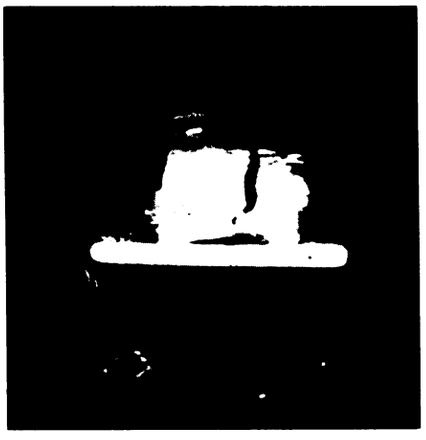
Before heating, the furnace was purged of air and filled with an inert gas, usually nitrogen. X-ray scans began when the coal sample, two to three inches across, reached about 212° F, and were repeated at intervals ranging from once every 30 seconds to once every 10 minutes.

Researchers monitored the process via computer reconstructions of the coal scans on a television screen. False color applied to the TV images enhanced their interpretations. Areas of maximum electron density were colored red, minimum densities appeared blue. Oranges, yellow and green visually punched out regions of intermediate density. Density changes result largely from coal "cracking," where chemical bonds weaken under heat and release hydrogen, methane, hydrogen sulfide and other hydrocarbons.

In the future, this technique could prove useful in determining gasification rates for different coals, or in visualizing how various coal minerals catalyze gasification, liquefaction and combustion. □

Photos: GE





Coal enters gasifier, which slides into CT scanner (right). Coal shown "melting" from solid, at 212° F, to frothy-looking foam (below, clockwise from left).

Mapping Mimas — with more to come

Closest to Saturn of the planet's nine "established" moons (as opposed to about half a dozen lesser objects discovered in recent years from spacecraft and earth-based observations) is Mimas, second smallest of the bunch at 390 ± 10 kilometers across. With the exception of huge Titan, the group consists of intermediate-sized bodies (between the likes of Jupiter's Ganymede and Mars's Deimos), several of which have intrigued scientists with signs of possible internal activity despite low densities that suggest only small heat sources at their cores. As the near-baby of the family, Mimas is almost down in the range of little chunks that one might expect to have been free of inner stresses and strains, and its low density (1.2 ± 0.1 grams per cubic centimeter) indicates it to be an ice-rich moon that probably formed with even fewer heat-producing radionuclides than a similarly small ball of solid rock. Yet photos taken by the Voyager 1 spacecraft show what may be evidence of at least some source of significant stress in Mimas's crust.

The photos have now been combined into a preliminary map of the surface (see pp. 204-205), prepared at the U.S. Geological Survey's Branch of Astrogeologic Studies in Flagstaff, Ariz. Mimas is by far the smallest of the four established Saturnian satellites photographed clearly enough for mapping (Rhea, Dione and Tethys, whose maps appear in SN of Feb. 14, Feb. 28 and March 14 respectively, are all more than 1,000 km across), but the close-up images are among the sharpest.

The most conspicuous feature seen is a huge impact crater, a third the diameter of Mimas, with towering walls and a central peak about the size of the whole Martian satellite Phobos. Also visible, however, are a number of linear grooves, some as much as 90 km long, 10 wide and 1 to 2 km deep. They could be fractures resulting from impacts, but they could also be signs of stress patterns born of internal sources.

Late in August, Voyager 2 will fly through the Saturnian system, taking pictures that will not only enable improvement of the four preliminary maps, but add several new ones to the list. Besides Hyperion (the one established satellite smaller than Mimas), there will be close looks at Enceladus (believed subject to tidal heating that may produce an unusual surface appearance) and Iapetus (of which one hemisphere is several times brighter than the other). Meanwhile, USGS planetary cartography chief Ray Batson hopes to try mapping some of Saturn's smaller moons, as well as Phobos, Deimos and Jupiter's Amalthea. The problem is deriving a suitable map projection for their irregular shapes. It may, Batson says, "have to be something like a 'potatographic.'" □