Raking theory over the coals

A new recipe for cooking up some coal in the laboratory casts doubt on the widely held theory about how nature makes that material.

According to conventional geochemical wisdom, coal began forming during the Carboniferous Period of the Paleozoic Era, when the earth was mostly steamy swampland. When the huge plants that flourished in that moist climate died, they fell into the warm swamp waters where they were decomposed by fungi and bacteria. Layers upon layers of the decomposing masses of dead plants gradually were transformed by immense pressures and temperatures into coal, according to the widely held theory.

But research led by Randall Winans and Ryoichi Hayatsu of Argonne National Laboratory in Argonne, Ill., shows that the process could have involved materials less decomposed and temperatures lower than heretofore imagined. In work to be described in September at the International Organic Geochemistry Conference in the Netherlands, Winans and colleagues made simple coals by heating lignin—a sort of "glue" for the cellulose fibers in woody plants — to about 300° F in the presence of Montmorillite or Illite clay.

Running that procedure for periods ranging from two weeks to nearly a year, the Argonne researchers discovered that the longer heating times produced higher-grade coals (which release more heat energy, or BTUs, per pound than do lower-grade ones). In addition, Winans and associates found that the clays appear to serve as catalysts, or substances that speed the reaction, since the lignin is fairly unreactive in their absence.

Winans believes that nature used the same recipe for forming coal. He notes that temperatures around 300° F are fairly common in geological formations and that clays are found in natural coal. Additional evidence, Winans says, comes from the work of Patrick Hatcher of the U.S. Geological Survey in Reston, Va., who, with the aid of analytical chemistry probes has found lignin structures in precursors to coal such as solidified wood.

The objective of such research, Winans says, is to understand the precise chemistry of coal and then to apply what is learned to industrial processes. The work could lead, for example, to the development of methods for converting lower grade coals to higher grade ones, for burning coal more "cleanly" or for producing new coal-based raw materials.

Chemistry capsules

- This year's chemical industry best seller list—compiled annually by CHEMICAL AND ENGINEERING NEWS (C&EN) — indicates that Dupont, Dow Chemical, Exxon, Monsanto and Union Carbide were the five U.S. front-runners in 1982 sales. The list was published in the May 2 C&EN.
- The next time you chomp down on a particularly crispy pickle, think of Ronald Buescher and J. Michael Hudson of the University of Arkansas in Fayetteville. They developed a method for inhibiting the softening of pickles—a method now being increasingly adopted by pickle-packing companies. Buescher described the method at the Institute of Food Technologists' recent 43rd annual meeting in New Orleans, La.

Pickles soften when they are victimized by naturally occuring microorganisms that excrete the enzyme polygalacturonase, which helps to break down the pectin that holds the pickle cells together. Buescher found that adding calcium to the brine solution where pickling cucumbers are placed leads to the formation of calcium pectates that can ward off enzyme attack.

Companies that have not yet adopted the calcium method for keeping their pickles crunchy rely on the tedious process of draining and refilling their 9,000-gallon pickle tanks in order to flush out the annoying enzyme; or they inhibit the enzyme by maintaining in the brine high salt concentrations, which ultimately are waste-disposal problems.

Rethinking the Charleston quake

In 1886, two days after an earthquake struck in Georgia, an editorial writer for the Atlanta *Constitution* noted the increasing occurrence of small quakes in the southern states — an area normally viewed as earthquake-free (SN: 10/10/81, p. 232). "Something strange seems to be happening," he wrote. "Further developments are awaited with intense interest." The quake turned out to be a foreshock, and his curiosity was satisfied three days later when a severe quake demolished much of Charleston, S.C. It was the worst earthquake known in the Atlantic seaboard/Appalachian area in at least the past 300 years.

Such quakes are difficult for scientists to explain because they happen in the middle of a crustal plate rather than at the margins where earthquakes are commonplace. Now, researchers from Lamont Doherty Geological Observatory in Palisades, N.Y., are using snippets gleaned from thousands of newspaper issues from the southern states to piece together the record of earthquakes before and after the Charleston quake.

Leonardo Seeber and John Armbruster find that the events leading up to and following the Charleston quake were evident over a much wider area than previously believed. Widespread examples of strain and soil liquefaction are consistent with tectonic, or large-scale crustal, movement. The researchers believe their findings support their hypothesis that earthquake activity in the southern Appalachians bears some similarity to that in the Himalayas, where the crust moves along extensive, nearly horizontal faults called master thrust faults. Such a feature has been identified from Tennessee and halfway through Georgia, but whether it continues to the coast is debated.

Armbruster says that prior to the large Charleston earthquake, there was movement without earthquakes along the master thrust fault, and that the stress was released on secondary faults (connected to the master fault) throughout the region. These quakes formed a doughnut-shaped pattern around South Carolina. After the Charleston quake (on the master fault) there was a "big burst of activity over a wide area, filling up the hole in the doughnut," Armbruster says. "We think there is a distinct pattern prior to the Charleston earthquake." Identification of such a pattern may help scientists assess when strain is building up to another major quake. The researchers suggest that slip along the major fault is encouraged by the movement of sediment from land to the offshore basin. This allows the continental margin to tilt upward as weight is removed from the northwest, and the upper slab of crust to slide to the southeast.

Glass blades: A cut above the rest

Blades made from volcanic glass not only cut costs, but also outcut conventional blades used in surgery, says anthropologist Payson Sheets of the University of Colorado in Boulder. While excavating obsidian glass blades 12 years ago in El Salvador, Sheets decided to investigate the blades' cutting properties. First he learned to manufacture the blades using the fracturing process used by the Aztecs and Mayas 2,500 years ago. Then, using an electron microscope, he compared the cutting edges of the obsidian blades to those of modern disposable steel scalpels and razor blades, and to diamond scalpels, the sharpest surgical tools available. He found that the glass blades were sharper than either steel blade, and incidentally, that the razor-blade edges were finer than the steel scalpel edges. The obsidian blades turned out to be two to three times sharper than diamond scalpel blades, but the real advantage is the cost, Sheets says. Obsidian blades would cost about $10 apiece, compared to $1,000 to $3,000 per diamond scalpel. Commercial production is years away, but tests are in the works: Boulder eye surgeon Firmon Hardenbergh has used the glass blades in removing cataracts, and finds them more precise than either conventional or diamond scalpels.