vironmental impact of pumping the water out of the well. Although Dorfman and crew will be monitoring air, thermal and noise pollution, in addition to microseismic activity, their only real environmental concern is land subsidence. While subsidence of land is known to occur when water is withdrawn from very shallow depths, the effect of pumping water from much deeper depths, such as from the Gulf Coast aquifer, is not yet known. To monitor possible subsidence, highly sensitive tiltmeters have been installed at the well site. "If a cockroach walks across the location, I'll know about it," Dorfman says.

The environmental and water-utilization investigations, along with legal and institutional studies, will continue over the next two years. By 1986, Dorfman hopes to begin small-scale commercial production of gas from the basin, generating about 1 trillion cubic feet annually by the year 2000 (the United States now uses 19 trillion cubic feet per year). Dorfman expects little more than these small-scale geothermal developments as long as conventional sources of gas and oil continue to provide the best return on investment. Although he sees an "increased interest" in geothermal development, "accelerated activity" in the field is still "down the road." □

The quest for a catastrophe

The sudden extinction about 65 million years ago of half to three-quarters of the living species on earth, as evidenced by microfossils in sediment samples from the boundary between the Cretaceous and Tertiary periods, has intrigued researchers for many years. Last year, the University of California's Walter Alvarez and colleagues reported on samples from Italy and Denmark that contained excesses of the element iridium typical of extraterrestrial materials, inferring that such anomalies might have been due to a huge meteorite striking the earth. Dust from such an impact, they reported (SN: 1/12/80, p. 22), might have lingered in the atmosphere for several years, shutting off sunlight effectively enough to inhibit photosynthesis and cause the extinctions. Other scientists have subsequently found similar iridium anomalies in Spain (which also showed an excess of osmium) and New Zealand (SN: 6/14/80, p. 381).

Now a researcher has taken another look at samples from the Cretaceous-Tertiary boundary period in Denmark, measured concentrations of nearly all the noble metals (iridium, osmium, gold, platinum, nickel, cobalt, palladium, rhenium and ruthenium) and compared them with samples from meteorites—representing high, "cosmic" abundances — and from typical, "terrestrial" basalts from the Columbia River. And according to R. Ganapathy of the J.T. Baker Chemical Co. in Phillipsburg, N.J., the likelihood that the boundary samples are of extraterrestrial origin looks greater than ever. Not only did all of the elements on the list show up in the boundary samples at levels well above those normally seen in terrestrial materials, he reports in the Aug. 22 SCIENCE, but the pattern of their abundances generally matches the extraterrestrial one. (The boundary samples have lower absolute abundances than do the meteorite samples, but Ganapathy points out that the impact would have tossed up a lot of terrestrial material that would later mix with the resettling meteorite debris. The clay in the boundary samples, he says, now contains about 7 to 8 percent meteorite material.)

How big a meteorite might have been involved? The "part-meteoritic" boundary clay containing the noble metals studied by Ganapathy was in a layer about 2 centimeters thick. If the meteorite material was carried around by the atmosphere long enough to have been evenly distributed over the globe at that rate, the scientist says, the impacting object would have been 11 kilometers in diameter and weighed 2.5 trillion tons. (An alternate source of the "extraterrestrial" material—a nearby supernova — was discounted previously by Alvarez on the basis of plutonium 244 and iridium 191:193 data. Osmium 184:190 ratios, reports Ganapathy, support the same conclusion.) □

Noble-metal abundances in two clay samples from the Cretaceous-Tertiary boundary in Denmark, compared with abundances from a meteorite and from a terrestrial basalt.

Element	Sample 4 (207.8 mg)	Sample 5 (243.4 mg)	C1 chondrites (4)	Columbia River Basalt (5)
Ir (ppb)	47 ± 9	55 ± 6	514	0.0011 to 0.012
Os (ppb)	40 ± 1	49 ± 2	480	≤ 0.01
Au (ppb)	8.8 ± 0.2	12.3 ± 0.2	152	0.35 to 1.33
Pt (ppb)	24 ± 5	17 ± 6	900	
Ni (ppm)	310 ± 45	322 ± 35	10,300	7.3 to 13
Co (ppm)	38 ± 1	46 ± 1	483	28 to 38
Pd (ppb)	45 ± 8	53 ± 8	460	≤ 0.03
Re (ppb)	35 ± 1	59 ± 1	35	0.64 to 1.06
Ru (ppb)*	37 ± 28, 39		690	

*Ruthenium was determined only in sample 1

R. Ganapathy/Science

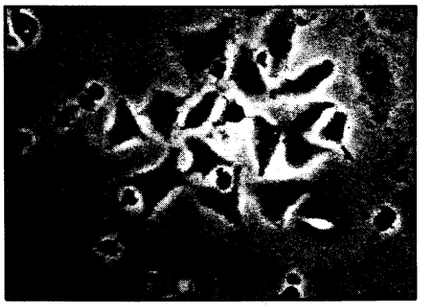
Ozone: Pollutant Slows cancer growth

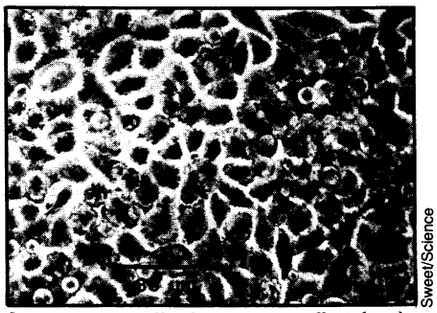
Ozone as an air pollutant causes major problems for persons with diminished lung function and it causes respiratory difficulties and discomfort in healthy persons. In the laboratory it causes problems for cancer cells. Ozone selectively inhibits the growth of cancer cells in culture, say five St. Louis researchers from governmental agencies and the Washington University School of Medicine.

The team, admittedly surprised by their discovery that cancer cells are more sensitive to ozone than are normal cells, made their finding while looking for a cell culture with which they could measure the harmful effects of pollutants. Using a chamber to hold cells in an ozone-suffused controlled atmosphere, they tested breast, lung, epithelial and uterine cancer cells and normal lung cells.

The growth rate of cancer cells, they found, was inhibited at a rate dependent on the ozone concentration, independent of the type of cancer. At 0.3 parts per million (ppm) of ozone, cancer cells reproduced at 60 percent of the rate of normal lung cells in the chamber; at 0.5 ppm, the rate of growth was 40 percent. When the researchers upped the ozone concentration to 0.8 ppm, cancer cell growth was inhibited 90 percent, and normal growth was inhibited less than 50 percent. "Evidently," they conclude, "cancer cells are less able to compensate for the oxidative burden of ozone than normal cells."

One possible mechanism, they suggest in the Aug. 22 SCIENCE, is that ozone affects glutathione molecules, which neutralize oxidizing chemicals by donating hydrogen atoms. As glutathione is used





Sweet/Science

Lung cancer cells show ozone effect (top).