ments of the earth's surface in response to differences in density. This resulted in some ironies: V. V. Beloussov of the Soviet Academy of Sciences, an adamant disbeliever in continental drift, found himself chairing a session on the earth's interior that included several papers on plate tectonics.

In spite of the excitement over plate tectonics, the 24th International Geological Congress reflected the concern that has been growing in many scientific organizations over the uses to which science may be put. Geologists now seem to be trying to undo the damage some of their colleagues, however unwittingly, may have done to the environment. And as Harry V. Warren of the University of British Columbia pointed out, geologists "have the unique knowledge necessary to do something about it." □

Was the universe born in a clumpy big bang?

Among cosmologists who believe in the big-bang theory—and that probably includes a majority nowadays—one of the important questions is whether the cosmic fireball that came out of the bang was smooth and homogeneous or clumpy and turbulent. The universe of today is both clumpy and turbulent: Matter is grouped into galaxies and clusters of galaxies, and circular motions, small and large, are characteristic of objects and groups of objects.

Many cosmologists wonder how a smooth beginning could lead to the present state (SN: 2/26/72, p. 140). Evidence pointing toward an inhomogeneous beginning is now adduced by Peter George Gross of Yale University as a result of studies of the composition of old stars in the globular clusters of stars surrounding our galaxy. Gross' conclusions were presented at the recent meeting of the American Astronomical Society in East Lansing, Mich.

Helium is one of the most abundant elements in the universe, and it is the first nuclear species not an isotope of hydrogen that can be made when nucleosynthesis starts with free protons and neutrons. The usual big-bang picture is that the universe started as electromagnetic radiation which, as it expanded and cooled, produced elementary particles. After further cooling, synthesis of nuclei becomes possible, and eventually ionized nuclei and ultimately neutral atoms appear. According to theories that start from a smooth fireball, the amount of helium produced

Cyclic AMP: 15 years later

In 1957, medical researchers made a discovery that would have a profound bearing on subsequent research on hormones and cell physiology. It was cyclic AMP. Since then the naturally occurring cell chemical has been found to transmit the messages of virtually every hormone in the bodies of man and animals (SN: 12/12/70, p. 450). The compound has also been identified in plant cells and bacteria, where it appeared to interact with nutrients rather than with hormones.

Sessions on cyclic AMP at the meeting of the American Chemical Society in New York City this week reveal that the challenge now facing scientists is to find out what cyclic AMP does. "There are a cascade of events at the cell boundaries," declared Theodore W. Rall of Case Western University, and a co-discoverer of cyclic AMP.

During the past five years or so, for example, scientists have noted interactions between cyclic AMP and prostaglandins. Prostaglandins, like cyclic AMP, are a discovery of the past 15 years. They, too, have been found in virtually all mammalian tissues and been shown to exert a plethora of physiological effects (SN: 10/24/70, p. 306). But unlike cyclic AMP, prostaglandins are a family of closely related chemicals. They act as local chemical messengers between cells rather than limiting their activities to within cells as does cyclic AMP. Prostaglandins are also leaps ahead of cyclic AMP in potential therapeutic roles—labor inducer, post-coital contraceptive, nasal decongestive. Interactions between prostaglandins and cyclic AMP were first noted five years ago by R. W. Butcher of the University of Massachusetts School of Medicine. They have since been confirmed by other researchers.

As Butcher explained at the ACS meeting, the interactions he and others have observed so far consist of prostaglandins increasing or decreasing the levels of cyclic AMP in the cells. "Oxidation is far more common than inhibition," he says. The prostaglandins, he explains, may serve as intermediates between hormones and cyclic AMP in the hormones' target cells, or they may mimic the actions of these hormones.

During the past two years Ferid Murad at the University of Virginia and some other researchers have come up with the first diagnostic use of cyclic AMP. They have found that high levels of cyclic AMP in urine generally indicate high levels of parathyroid hormones in the kidneys. "With some of our recent studies," Murad said at the ACS meeting, "we simply can categorize different kinds of parathyroid defects [e.g. kidney stones]." Rall indicated he is presently looking for interactions between cyclic AMP and neurohumors—nerve chemicals produced in certain nerve cells that bridge interactions between nerve cells. Rall said he is finding that interactions exist, as are some other nerve and endocrine researchers (SN: 8/5/72, p. 93). "Whether cyclic AMP will have a role in the diagnosis of neurological diseases, I do not know," he admitted.

I. H. Pastan of the National Cancer Institute is looking for the possible implications of cyclic AMP in cancer. He is using embryo cells as models for cancer cells because he says they share certain properties (for example, rapid growth). By raising the level of cyclic AMP in these cells, he is finding that they behave more like non-embryonic cells. They grow more slowly, move around less and are able to make certain proteins they are otherwise not able to make. He said he did not think anyone had yet looked at the levels of cyclic AMP in cancer cells themselves.

Murad pointed out, however, that he had done just that and had found cyclic AMP to be present in cancer cells in rather high amounts. Such a finding counters Pastan's. Pastan suggests that high amounts of cyclic AMP might turn off cancer cells. Consequently Pastan pointed out that no one really knows what normal levels of cyclic AMP in the body are. He suspects they vary from tissue to tissue and that "cyclic AMP may inhibit growth of one kind of tissue but not of another." So, he says, it would be difficult determining whether cyclic AMP levels in cancer tissues are normal or not.

Might cyclic AMP be used as a diagnostic marker for cancer any time in the near future? Pastan, Rall, Butcher and Murad all say "no." The problem, they agree, is that cyclic AMP, like the prostaglandins, is active in so many tissues and plays so many roles that it is incredibly difficult to link them with the disease state. Rall crisply put cyclic AMP in perspective: "Certainly not all hormone actions can be explained by cyclic AMP. As time goes by we will find other substances like cyclic AMP. We are looking at the tip of the iceberg, rather than at the whole story."

during the time when fireball conditions were favorable to its formation is not enough to account for the present helium abundance. On this basis it is assumed that much of the present helium was formed later by nuclear processes inside stars.

If that hypothesis is true, then young stars should contain a higher proportion of helium than old stars because the young stars are made of material that has already been processed through stars one or more times while the old stars are made of more primeval matter. What Gross has found is that the old stars in the globular clusters have more helium than they ought to.

His work began with making computer models of stellar compositions. Different assumptions of composition led to different values of surface gravity and surface temperature. These predictions can be compared with observation since the values concerned can be deduced from observation of a star's light. Gross found that his models were particularly sensitive to the amount of helium in the star, and very insensitive to the many other parameters involved. "This is where the whole thing paid off," he says. "It just so happened."

Comparing his models with observations by K. A. James, R. D. McClure, E. B. Newell and W. H. Osborn, all of Yale, Gross found that the helium content of the older stars is 30 to 45 percent in contrast to 22 to 25 percent for the younger stars in the galactic disk.

What Gross thinks is the best explanation is that the fireball started out clumpy. The rate of helium production is very sensitive to the temperature; that is why in the smooth-fireball theory there is a certain period of optimum temperature when helium production is high. If the fireball had variations of density, the laws of thermodynamics demand variations of temperature. The result is that in the denser areas more helium is produced. These denser areas are also likely to be the precursors of galaxies. Also, if there are turbulent motions in the fireball, areas of low angular momentum will produce more helium than areas of high angular momentum. The low-angular-momentum areas condense into galactic halos; the high-angular-momentum areas condense to galactic disks.

There is one mechanism by which the extra helium could be non-primeval. Large supermassive objects (masses 100,000 times the sun) might have condensed before stars and processed large amounts of hydrogen into helium. Gross intends to look into this possibility in future work, but his intuition is that even if the superdense objects existed, they could not have done enough: Most of the extra helium should still be of primeval origin. □

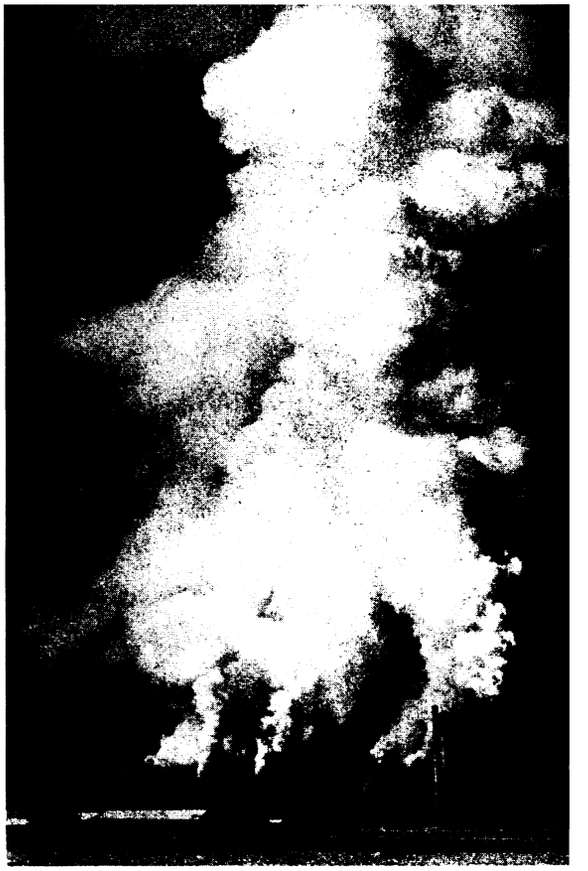
Environmental success: Pulp industry's cleanup

From the environmentalist point-of-view, the pulp and paper industry was the most damned of industries two years ago. Pulp mills belched foul-smelling gases from their boilers and disgorged oxygen-demanding organic wastes into waterways. A single pulp mill could blight life in an entire city, as was the case in Missoula, Mont., where a combination of emissions from the Hoerner Waldorf mill west of town and frequent inversion layers often turned the mountain-surrounded town into a great stinkpot. In 1970, the Council on Economic Priorities (CEP), a respected nonprofit firm that studies social aspects of business activities, termed the industry one of the nation's worst polluters. At the same time, the Missoula situation gained national publicity as local environmental groups brought a landmark suit against Hoerner Waldorf.

Today Missoula citizens are breathing easier. So are residents near pulp mills all over the country. A new CEP report, issued last week, says the pulp and paper industry has made a remarkable effort to control pollution during the past two years and that the mills by 1975 will probably approach 100 percent of "adequate pollution control."

The reasons for the striking turnabout are many. Vigorous enforcement of new antipollution laws backed up by a public outraged by the highly visible —and highly smellable—pollution is one reason. (Lawsuits, such as the one brought by the Environmental Defense Fund in cooperation with the local groups in Missoula, created widespread anti-company publicity, although the Missoula suit was never wholly resolved in court.) Another reason is that there was no need to develop exotic technologies for control. A final, and often important, reason was the unique pollution-control financing devised by Hoerner Waldorf and Missoula County and since applied elsewhere.

"Many of the recent pollution control projects in the paper and other industries are being financed through some form of municipal bond," says the new CEP report. In Missoula, the county floated $14 million in tax-exempt bonds and gave the money to Hoerner Waldorf, which is now using it for pollution controls and necessary related plant modifications. Hoerner Waldorf will pay off the bonds—at the lower interest rate made possible because bondholders are not taxed on their interest—and nearly everyone benefits. ("Only the Internal Revenue Service loses," says CEP, a slight distortion, since when IRS loses, the nation's taxpayers make up the difference.)



Harley Hettick

Missoula mill in 1970: Much better now, but still not a rose garden.

CEP admits the cleanup job lags in some areas, and Missoula residents report that the town does not yet smell like a rose. Hoerner Waldorf has cleaned up only one of its three pulp boilers, but the other two are scheduled for cleanup within a year. University of Montana scientists will then monitor air quality for another year to determine the effectiveness of the measures. "But there is no doubt that progress is being made," a Missoula environmentalist told SCIENCE NEWS. Hoerner Waldorf, besides abating the odiferous sulfur compounds from its pulping boilers, has also installed particulate abatement devices, as well as secondary treatment facilities for effluents that go into the Clark Fork River.

CEP says the situation varies from mill to mill, but that the Missoula gains are generally reflected throughout the country. Weyerhaeuser, once an industry leader in pollution abatement, still has severe pollution problems at its Longview, Wash., mill, however, and other companies, although they have cleaned up their highly noxious emissions into the air, still lag in water cleanup. Several other companies that to date have done little have now made firm commitments to clean up. Despite a sometimes spotty picture, the pulp and paper industry, says CEP, is "years ahead of other industries, such as utilities and steel." □