SCIENCE NEWS of the week

The Trouble with Tracking Turbidity

Clear drinking water flowing from a household tap may contain large numbers of bacteria and other microorganisms, despite meeting standards set by the Environmental Protection Agency (EPA), say two researchers at the University of Missouri at Columbia (UMC). These bacteria, they say, although not necessarily harmful to human health, can affect the taste and smell of drinking water and contribute to the corrosion of water pipes.

The problem, says UMC civil engineer John T. O'Connor, is that water suppliers rely mainly on measurements of turbidity (water murkiness) to monitor a treatment plant's effectiveness in keeping bacteria from passing through a plant's filtering system into the finished water. The assumption is that filtering water to remove debris such as sand or clay particles also reduces the number of microorganisms that would otherwise be found in drinking water.

O'Connor and microbiologist Blaise J. Brazos contend that utilities should use microscopic techniques to count directly the number of bacterial cells present in both raw and treated waters. Such techniques would give utilities a better idea of how well treatment plants work, they say.

Recently, O'Connor and Brazos conducted the first major survey of its kind of water systems to determine the actual number of bacterial cells found in treated water. Using a technique well known in microbiology but rarely used in drinking water research, they counted the number of cells present in water samples by catching the cells in special filters, staining them with a fluorescent dye and observing them in ultraviolet light under a microscope.

In samples from 83 Missouri water systems, the direct count revealed from 1 million to 1 billion cells per liter in treated water. The researchers also observed that two treatment plants could have water with the same measured turbidity, yet one would be filtering out bacteria much more effectively than the other.

"It is incumbent upon us as waterworks scientists, engineers and professionals to find out why this can happen," O'Connor said last week at the American Water Works Association annual conference held in Washington, D.C.

Currently, EPA's "interim" drinking water regulations governing microbiological contamination specify turbidity as one of only two standards that must be met. Water, when it leaves a treatment plant, must have a turbidity below 1 NTU (a specially defined unit of measurement related to how much light is scattered by the particles in a sample of water).

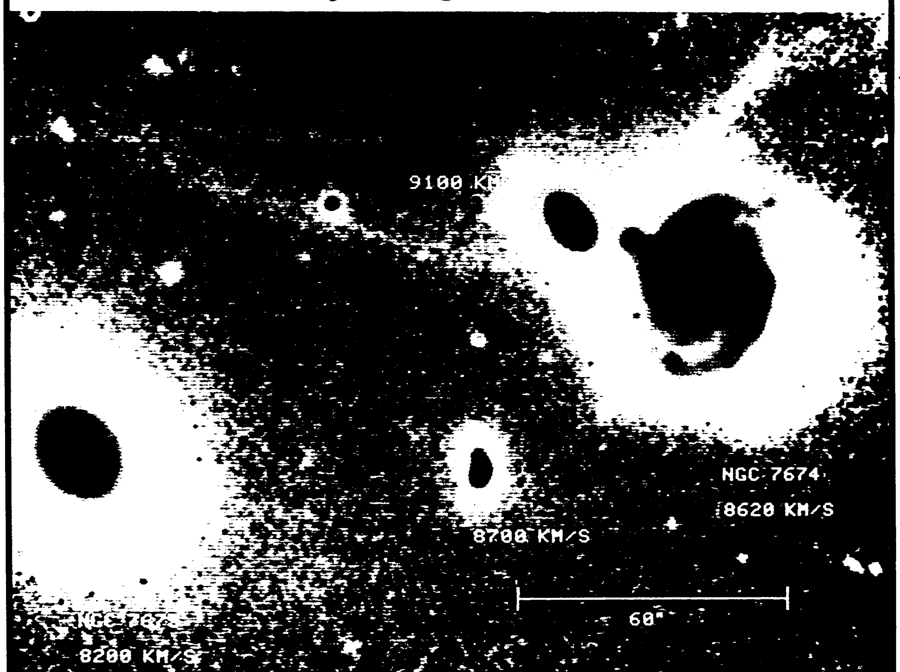
"The specific purpose of the turbidity standard was to encourage the filtration of surface water supplies," says Joseph A. Cotruvo, director of the criteria and standards division in EPA's drinking water office. "It was not intended as a quantitative measure of bacteria."

Cotruvo concedes that turbidity is not a good index of total bacterial content in water but argues that removal of turbidity correlates well with removal of bacteria known to cause disease. Historically, a combination of filtering and disinfection using chlorine has been effective in ensuring the safety of drinking water, he says.

Very little is known about the microorganisms that live in systems that carry drinking water, says O'Connor. In the past, most microbiologists assumed there was nothing there. "Because of what we are finding, we are now looking at the ecology of drinking water microorganisms," says Brazos. "It's a very dynamic and very diverse ecological system, much more so than people thought. These bacteria are responsible for tastes, odors, corrosion and many other problems."

Raymond H. Taylor of the California Water Service Co. in San Jose is one of many water-quality engineers who aren't convinced that turbidity measurements are useless. Moreover, he says, direct counting of bacteria has some inherent problems. "Most people feel that it doesn't

Of tides and Seyfert galaxies



MacKenty

Seyfert galaxies, like the ones in this picture, often show curious shapes. Many of their features seem to be the result of tidal interactions with other galaxies. One of those, NGC 7674, shows here two tails that seem to be the result of extreme tidal interaction with some other galaxy.

Seyferts are galaxies with particularly active and energetic nuclei. Astrophysicists believe them to be intermediate between "normal" galaxies, which have less activity in their nuclei, and quasars, which are considered the most energetic of active galactic nuclei. Astronomers have thought that Seyfert galaxies show evidence of tidal interaction more often than less active galaxies. The survey that produced this picture was done by John W. MacKenty of the University of Hawaii. It shows that 25 to 30 percent of Seyferts have such peculiar shapes. This result supports the opinion that they are involved in tidal interactions more often than are other galaxies. Astrophysicists believe that the source of the energy emitted by galactic nuclei is an engine powered by a black hole. Such tidal interactions may be a way of obtaining a continuous supply of gaseous fuel for the black hole.

MacKenty observed with the University of Hawaii's 88-inch telescope on Mauna Kea and presented his report in Charlottesville, Va., at the recent meeting of the American Astronomical Society. — D.E. Thomsen give you a really representative number of bacteria," he says. "You count everything — those that are still alive, those that have been killed by disinfection. The method really hasn't been widely evaluated, and I'm not sure that anybody could tell you how to interpret the results."

Many utilities already regularly measure a wide variety of physical and chemical parameters for water quality, says Taylor. The problem is that some water suppliers, particularly those with a small number of customers, do only what is required, and that may not be enough to ensure high-quality water all year long.

— *I. Peterson*

Unearthing the earth's history

When and where California's next big earthquake will occur and how bad it will be are questions geologist Kerry E. Sieh of Caltech in Pasadena has been trying to answer with some pioneering techniques in the past few years. His most recent study, a collaborative effort with Ray Weldon of Occidental College in Los Angeles, published in the June Geological Society of America Bulletin, supports earlier predictions that the event will occur in the southernmost 300 kilometers of the San Andreas fault, the geologic seam running northwest/southeast along the length of the state. But it also suggests that the quake may actually be overdue, by about 115 years.

Sieh's approach is to gather detailed information about past earthquakes at specific sites in order to establish probabilities about future quakes (SN: 12/24 & 31/83, p. 404). Sieh and Weldon excavated a site on the San Andreas fault at Cajon Pass, 60 miles northeast of Los Angeles, and pieced together the site's earthquake history over the last 1,500 years. "Our techniques," Sieh told Science News, "were not unlike those archaeologists use."

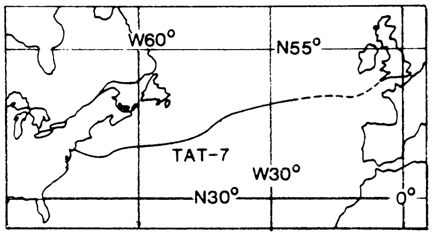
The displacement of sedimentary layers of peat, silt and sand at the excavation site yielded "tentative evidence," says Sieh, that since the late 13th century, four "really big" earthquakes with an average recurrence of 150 years had occurred there. The last large earthquake, the researcher says, was in 1720 or 1725. The excavation also revealed that the overall rupture length of a well-known 1857 earthquake in Los Angeles was perhaps shorter than those caused by the earlier four, a finding suggesting that the 1720 quake should perhaps be viewed as the most recent in a regular pattern of large earthquakes.

Weldon told Science News, however, that the findings should be viewed cautiously. The recurrence rates were based on averages, he notes, "and averages don't make earthquakes — it could still wait another 50 to 100 years."

— *J. Mathewson*

Cable tests for current leaks from the core

Scientists have few clues with which to understand the complex swirlings of conducting fluids in the earth's core. Most clues are embedded in the behavior of the magnetic field generated by the core currents, which act as a giant dynamo. But 20 years ago English geophysicist Keith Runcorn suggested another way to get at the workings of the geomagnetic dynamo humming in the core. He proposed that the core currents might leak up through the mantle and crust and could be measured on the surface of the earth. Now, in the July 5 Science, a group of scientists has taken him up on his idea and carefully tested it.



Lanzerotti et al./SCIENCE

Scientists made use of AT&T's TAT-7 telecommunications cable that now spans the Atlantic from Tuckerton, N.J., to Lands End, England (solid and dashed lines). In March 1983 they measured the voltage drop across 4,476 kilometers of cable (solid line) to see if they could detect DC currents leaking from the core of the earth.

"We thought Runcorn's proposal was rather reasonable," says Louis Lanzerotti of AT&T Bell Laboratories in Murray Hill, N.J. "Given what we know about the core and the mantle, one could concoct reasons why we might or might not see something at the surface of the earth."

To search for possible leakage currents, Lanzerotti and his colleagues, along with two Italian researchers, used a telecommunications cable that AT&T was laying across the Atlantic. Runcorn himself and, independently, a group of Canadian scientists had performed similar experiments years ago with an abandoned telegraph cable in the Pacific Ocean. But Lanzerotti's group felt that the condition of the cable and its grounding were not known well enough in these past studies. The AT&T cable would enable them to do a much more careful and controlled experiment.

After laying 4,476 kilometers of cable, AT&T workers returned to shore for more, allowing the scientists to get 19 days of data with the unpowered cable grounded to the ocean floor. Using some fancy statistical footwork, the researchers separated out the direct-current (DC) component due to core currents from the tangle of alternating-current (AC) signals arising from a variety of sources, such as the erratic flow of ions in the ionosphere, that induce currents in the earth. They obtained a DC potential voltage drop (which is proportional to current) of 0.072 ± 0.050 millivolts per kilometer.

"The bottom line is that the potential drop over the surface of the earth is very small, almost zero," says Lanzerotti. According to calculations by theorists, this implies one of two possibilities. Having essentially no current at the surface might mean that the two main components of the earth's magnetic field — the toroidal part, which looks like a doughnut around the equator, and the poloidal or dipole part — have equal magnitudes at the core-mantle boundary. This supports one model of the dynamo put forth by Friedrich Busse at the University of California at Los Angeles. But even if that model were correct, the field deep inside the core might still be different from that at the core-mantle boundary.

The other alternative provides information about the mantle. It is possible, in theory, that the core currents are prevented from reaching the surface by a layer in the mantle that has a conductivity much different from that of its neighbors.

Now the ball is back to the theorists, who must try to reconcile these results with the other existing data.

In addition to using the cable to study the electrical properties inside the earth, the researchers have found a number of other applications for the cable and these will be reported in future papers. One of the most exciting prospects is to use cables for very sensitive monitoring of ocean tides on a large scale. Because seawater is a conductor, it can induce a current in a cable as the water moves through the earth's magnetic field. The cable measures the integrated effect of ocean flow, which can then be used to test oceanographic models that have relied primarily on data from isolated sea-level gauges on the coasts. — *S. Weisburd*

Action on export controls

After more than two years of debate, Congress last week approved a four-year extension of the 1979 Export Administration Act, which had expired last September (SN: 12/8/84, p. 358). The legislation gives the government authority to control exports for national security or foreign policy reasons.

Although the legislation contains a policy statement affirming the need to keep fundamental scientific research healthy by protecting the ability of scientists to communicate their findings freely (SN: 2/25/84, p. 117), missing is a clear description of the reasoning behind that declaration.

"Congress did not hear strongly from the scientific and academic communities," says Allan Adler of the American Civil Liberties Union. "The hopes that this legislation would put Congress on record that it was very concerned about export controls in this context have been disappointed." □