they would share their electronic data—although 94% said they would use other people's electronic data. Others prefer to see museums post their own images rather than give power to a centralized database.

But a few researchers have welcomed the idea. In South Africa, Francis Thackeray, manager of the Transvaal Museum collection in Pretoria, immediately offered to post photos and scans on the e-archive if it proceeds; already he has jointly published with Weber a CD-ROM of a famous, nearly complete 2.5-million-year-old skull known as Mrs. Ples.

No matter how fancy the technology, however, access relies on people's willingness to trust each other. "Getting researchers to give their data will be the most difficult part of this," says Meave Leakey. Even the National Museums of Kenya's request that visiting researchers share standard measurements of fossils has not been honored, she says.

One solution would be for funding agencies such as NSF to require that access to fossils be provided after a certain period, in the form of either high-quality images on the Web or access to casts. "The time has come for the community to discuss these issues," says Mark Weiss, physical anthropology program director at NSF, who plans a winter meeting on the topic. AAPA is considering action, too. Anthropologists filled a session on the topic of access at the annual meeting in April, where it was proposed that the association come up with voluntary guidelines. "As long as fossils remain tangible, fragile, and concealable items that are, in some cases, a source of revenue and power, then problems of access will always exist," Lee Berger of the University of the Witwatersrand wrote in the current AAPA newsletter. "But that doesn't mean the current levels of access cannot be improved upon."

However these efforts move forward, momentum is building for faster access to crucial fossils. Yet this is already having a chilling effect on fossil discoverers, who are moving to define and defend their policies. White says, "I'm afraid the consequences of this contrived momentum may ultimately serve nobody's purpose." He and other discoverers warn that any new guidelines will have to consider their rights, too. Otherwise, "it won't be worth it to go to the field," says Walker. And, as GWU's Wood notes: "Without their work, the rest of us would be out of a job."

–ANN GIBBONS

ELECTRONIC PUBLISHING

Online Pioneer Winds Up Lost in Cyberspace

The American Geophysical Union wants its electronic journals to be the next wave in science publishing. But some fear that it's gone off the deep end

Mary Scott was stumped. As a geology librarian at Ohio State University in Columbus, she was used to tracking down obscure references. But the request she received this April was unlike anything she had seen before. "A scientist was searching for a *Geophysical Research Letters* article he'd seen referenced in *Science*," she says, but the citation looked like gobbledygook: *Geophysical Research Letters* **29**, 10.1029/2001GL014304 (2002). "I had no way to figure out what issue we needed," Scott recalls. "All I could do was pull all the current year's issues from the shelf and go through each one."

Scott never found it; at that point, the article had appeared only in the electronic version of the journal. Her frustration is a symptom of what's gone wrong since the journal's publisher, the American Geophysical Union (AGU), took a belated leap last year into the world of electronic publishing. In giving its online journals pride of place, the organization abandoned traditional sequential page numbers in its paper journals. Early this month, AGU backtracked by adopting a four-digit "article number" that serves much the same purpose as a page reference. AGU officials hope that it and other changes will help them right a publishing ship that in the past year has been listing wildly. "It's really quite a mess," says Paul Lucey, a planetologist at the University of Hawaii, Manoa, who edits AGU's *Journal of Geophysical Research—Planets*. AGU's management "is focusing so much on electronic that they just discarded the print version."

AGU's woes stem from a bold come-from-behind strategy, says geophysicist Marcia McNutt, director of the Monterey Bay Aquarium Research Institute in Moss Landing, California, and immediate past president of the society. For decades, AGU—which publishes many leading journals in the earth, atmospheric, and oceanographic sciences—required authors to submit their papers practically ready for publication. The policy kept costs low but was hostile to new technologies, McNutt says. "In the 1980s, we considered alternatives but decided that, as a small nonprofit, we couldn't afford to be on the leading edge."

When AGU took the e-plunge in 2001, however, it went all out. Online papers, the organization declared, would be treated not as sneak previews of printed versions but as publications of record. The switch also paved the way for extras that scientists want but that hard-copy journals can't match, namely, "multimedia enhancements" such as videos, simulations, and three-dimensional chemical structures.

First, though, AGU needed a permanent way to tag on-

Disoriented. Geoscientists complain that AGU's identifier for online papers is next to useless for navigating its print journals.

ILLUSTRATION: TIM SMITH

line papers for citation in the scientific literature. Because page numbers are meaningless in cyberspace, AGU scrapped them and assigned each paper a 20-character string of numbers and letters called a digital object identifier (DOI). "Page numbers are potentially misleading, because they suggest that people should reference the printed version," says AGU's executive director, Fred Spilhaus.

The new scheme drew fire from the start. Scientists and librarians complained that AGU's cryptic tags were designed for search engines, not human beings. To use long, unwieldy DOIs "is ridiculous," says Peter Brueggeman, director of the Scripps Institution of Oceanography Library in San Diego, California. "People have enough trouble with shorter, traditional citations now. AGU offers no user-friendly, short, and simple citation scheme to get to the exact location of its articles," he says.

Online searches fare little better. Because scientific databases aren't designed to handle DOIs, it has been practically impossible to find an AGU article on most of the common scientific databases. "DOI is a monster change, and secondary databases can't handle it," says Tim Ingoldsby, director of business development at the American Institute of Physics (AIP) in Melville, New York. AIP's database is one of those that choked on DOIs, and the organization has assisted AGU with its publishing problems.

AGU acknowledges that its march into cyberspace has covered some rough terrain. Every few weeks its member newspaper, *EOS*, publishes another letter from management explaining a new problem with electronic publishing. But some geoscientists say the organization has been too complacent about the inconvenience the move has caused. "It's embarrassing," says Lucey. "The letters are frank and present the facts, but there's no apology."

The outcry climaxed at the society's annual spring meeting in late May, when the organization's board of directors vigorously debated a proposal for an unprecedented external review of the entire publishing program. The issue was raised by Jack Gosling, a solar physicist at Los Alamos National Laboratory in New Mexico and outgoing member of AGU's board, who says he feared that AGU's problems would cost the organization money and members. Gosling and fellow proponents of the review backed down only after AGU's management urged members to be patient. "The challenge for AGU is to be on the cutting edge of electronic publishing ... not the bleeding edge," says outgoing AGU council member Marvin Geller of the State University of New York, Stony Brook. At the same meeting, Geller tabled a successful motion calling for AGU's management to "take all steps" to reassure members that the publishing situation was under control.

AGU wasn't the first science publisher to do away with page numbers. When the American Physical Society (APS) declared its online journals to be the versions of record in July 1993, it exchanged page numbers for a six-digit "smart identifier." But APS has had fewer problems than AGU. "We tried to have something that people understand and recognize," says APS's editor-in-chief, Martin Blume. "With us, if you know the reference, you can construct the identifier and vice versa." (See box, above.)

Other science publishers are treading more cautiously into the electronic future. The American Chemical Society publishes papers online "ASAP—as soon as publishable," says Lorrin Garson, chief technical officer for the society's publishing division. "But when we print the journal, we use page numbers. Librarians and everybody else like page numbers. It's an important issue to please your customers. It's pretty much a no-brainer to retain them."

Even companies that specialize in online services still rely on paper. The scientific search database ChemAbstracts, for example, saves a hard copy of everything it cites. "Archiving of electronic material is something that we are unsure of. We need to use a method that we know works," says Chemical Abstracts Service's director of editorial operations, Matthew Toussant.

AGU officials say that the organization's citation problems are an inevitable—and temporary—cost of being a front-runner. "We believe that the move to the DOI as a citation standard may put AGU ahead of the curve, but the rest of the world will soon catch up," publications committee chair George Hornberger wrote in May to the e-mail discussion list of the International Aquatic and Marine Science Libraries and Information Centers.

But some geoscientists warn that AGU's determination to lead the pack could lead it down a blind alley. "AGU has assumed that the concept of fixed pages will be obsolete in the era of electronic publishing," says Scripps oceanographer Ralph Keeling. "But the whole browser-display environment is still evolving, and the technology we use for reading electronic media will almost certainly be very different in a decade or two. It's premature to proclaim the death of the page."

AGU's recent adoption of article numbers suggests that arguments such as Keeling's might be making headway. AGU will retroactively number all papers published between January and August. Future "hard copy" journals will publish numbered papers and will print a range of article numbers on each issue's spine—just as they used to do with page numbers. "In effect, people can now cite AGU articles without the DOI," Brueggeman points out.

Although the pagination crisis was the biggest fallout from AGU's leap into electronic journals, users have also raised other complaints. Late last year, AGU riled librarians at large universities by hiking prices so that online subscriptions cost twice as much as print ones. (By contrast, the American Meteorological Society charges no more than 31% extra for its online subscriptions.) Bottlenecks in production also have ruffled feathers. AGU's once-hefty *Journal of Geophysical Research*, for example, has shrunk to comic-book size as editors struggle to convert electronic versions of articles into print.

Will AGU's online teething problems be worth it in the long run? No one knows, Geller says. "Professional societies are facing a very perilous time in the transition to e-publishing," he says. "AGU chose to take the e-plunge all at once. Only time will tell if this was courageous or foolhardy."

–REBECCA RENNER

Rebecca Renner writes from Williamsport, Pennsylvania.

Deconstructing DOIs

Critics blast the American Geophysical Union's digital object identifier (DOI) as unwieldy but praise the American Physical Society's "smart identifier" for its user-friendliness.

AGU DOI

Geophys. Res. Lett. **29**, 10.1029/2001GL014304 (2002)
29 = the journal's volume number
10.1029 = publisher identifier (AGU)
2001 = year paper was submitted
GL = journal code
014304 = sequential article number
2002 = year of publication

APS "Smart Identifier"

10.1103/PhysRevC.65.041001
10.1103 = publisher identifier (APS)
PhysRevC = journal title (*Physical Review C*)
65.04 = volume, issue
10 = section of the journal
01 = article's position in section