ALL THAT GLITTERS...

Hap McSween

My father had lots of wise aphorisms, including "All that glitters is not gold." That old saying and this interesting *Elements* issue on gold prompt a timely perspective on how we conduct and archive our science. Mineralogy, petrology, and geochemistry—the main subjects of interest to the societies for which *Elements* was founded—have grown substantially in the numbers of practitioners and in their capacities to churn out huge amounts of analytical, experimental, and computational data. In fact, the volumes of data have become so large that government agencies are now exploring comprehensive, computer-based databases that can be interactively searched and utilized in research. But before these databases actually become reality, a fair question to ask is: *What are the gold standards for data, and how much data actually meet those standards?*

We all know that some laboratories produce better analyses than others. In implying that some analyses are substandard, I am not talking about fraudulent data—those cases are extremely uncommon, and our societies do a good job of policing that. Rather, I am referring to data produced by inadequately trained analysts and improperly supervised students, data from laboratories with poor sample-handling protocols and outdated instrumentation, and data with unacceptably large or even unknown uncertainties. Before we build global databases, should we not impose some screens on the quality of our analyses?

What are the gold standards for data, and how much data actually meet those standards?

Some readers might respond by noting that science is self-correcting and might suggest that the peer review process can be counted upon to weed out substandard data. That does occur, of course, but I doubt that journal editors and reviewers always have the analytical experience and expertise to recognize substandard data. It is also unlikely that funding agencies will recognize and support the acquisition of only those data that meet the gold standard. So, if you accept that policing of data quality is appropriate, whose job should it be? I suggest that our scientific societies should take the lead. We—that is, those scientists in each discipline—should define analytical standards and provide mechanisms for investigators to check their data against those standards.

I'm not alone in worrying about this issue. A new report by the U.S. National Academies (*Ensuring the Integrity, Accessibility, and Stewardship of Research Data in the Digital Age*, National Academies Press, 2009) addressed this matter, at the behest of several scientific journals. A major conclusion from that study is that defining guidelines for data integrity for the whole community of science is impossible, because of differences among the various disciplines. It thus falls to us, the practitioners in each field, to identify the gold standards for data in our discipline.

Consider the example of a scientific community that is already well ahead of the pack in this regard. High-precision geochronologists, who measure the isotopes of uranium, lead, and argon to define precisely the ages of rocks, have made considerable strides in setting a gold standard for themselves. They have established the EARTHTIME organization to coordinate their international efforts. The U-Pb laboratories are sharing standards, gravimetric solutions, and tracers, and the Ar isotope laboratories are exploring differences in sample pretreatments, irradiation and analytical protocols, and data reductions, all in a concerted effort to minimize interlaboratory biases and improve data quality. The importance of this effort to the geosciences is summarized by the mantra "No dates, no rates," and the recent successes of this group are apparent in published literature. However, this kind of self-inspection is not easy and, as noted by the effort's leader, Sam Bowring, "You have to check your ego at the door."

Another noteworthy example is provided by one of the member organizations of *Elements*, the International Association of Geoanalysts. This organization offers a proficiency-testing program for laboratories involved in the analysis of silicate rocks. They offer test samples for both whole-rock and microbeam techniques, as well as a compilation of reference materials. The Clay Mineral Society holds the Reynolds Cup biennially for the analysis of clay mixtures.

A related problem is how to control data quality in private laboratories that do custom work for others, when those data are later published in scientific contributions. Many laboratories provide their analyses of standards, but these are not usually included in publications.

These examples are from the world of analytical geochemistry, but similar approaches could be applied to other areas of the geosciences, including mineralogy, hydrologic and environmental studies, and experimental petrology and geochemistry. One colleague has noted that the literature describing experimental determinations of diffusivities, partition coefficients, solubilities, and the like contains lots of questionable data, and that nonexperts understandably have trouble separating good results from bad. Even disciplines like geologic mapping probably need to impose some quality control on the information that is incorporated in these global databases. Ensuring data quality may be especially important when those data are likely to be used to support the development of public policy.

Let me add a dose of reality here. I am not advocating that all published or archived data must necessarily achieve the same high levels of accu-

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THIS ISSUE

Gold! How can such a topic be covered in 36 pages of text? So many angles are possible, and so many books have been written on the various types of gold deposits, not to mention the cultural, historical, health, economic, industrial and scientific aspects of this treasured Earth material. This is the challenge every guest editor faces: how to give as broad an overview as possible while highlighting key frontier areas. Guest Editors Robert Hough and Charles Butt—our first guest editors from Australia—have risen to the challenge and orchestrated contributions from an international cast of authors. Of great interest to me was how gold nanoparticles are being investigated to aid the diagnosis and treatment of cancer.

One angle that is not covered in this issue, however, is the environmental impact of extracting a few grams of gold from a ton of rock and disposing safely of the resulting huge quantities of waste. To be fair, the topic of mine wastes would deserve a whole issue, and we hope to add this theme to our lineup in the near future. Proposals on this topic would therefore be viewed favorably by the editors.

Two of the articles in this issue make extensive reference to a 1979 Geological Survey of Canada publication by Robert W. Boyle (1920–2003), *The Geochemistry of Gold and Its Deposits*. I met Dr. Boyle and his family at the 1992 GAC-MAC meeting in Wolfville, Canada; he was a very kind and humble man, and I did not realize at the time that I was talking to a "giant," one of Canada's most distinguished geologists. Dr. Boyle spent his career at the Geological Survey of Canada and became a world expert on gold and silver deposits. He developed geochemical prospecting methods suited to the Canadian environment, and these became truly practical tools in mineral exploration. He published major works, notably *Gold: History and Genesis of Deposits* in 1987. The mineral boyleite was named in his honor. And his 1979 bulletin seems to have stood the test of time.

MULTISOCIETY CATALOGUE

Our 2010 multisociety catalogue is being mailed with this issue of *Elements*. This is the fifth catalogue we have published, and it is a truly cooperative venture involving several of the participating societies. I suggest you keep it handy during the coming year or give it to a colleague or student as an encouragement to join one of the participating societies and thereby receive *Elements*.

The idea of a multisociety catalogue was first put forward by Kevin Murphy of the Mineralogical Society of Great Britain and Ireland at the 2002 IMA meeting in Edinburgh. At the time, even though interest was expressed, the idea did not move beyond the discussion stage. It is therefore fitting that I turned to Kevin to help with assembling this catalogue, and I thank Kevin for his cheerful help.

SPECIAL OFFER

We are making a special offer to libraries and departments that will receive a subscription to *Elements* in 2010: for an extra $200, they can receive all back issues, from Volume 1, Number 1 to Volume 5, Number 6. Get them while copies last (see page 20 of catalogue).

ELEMENTS IS YOUR MAGAZINE

Several of our features need our members' involvement. If one of your colleagues has been recognized for his or her work or has done something extraordinary, consider submitting a short note and picture for **People in the News** or for your society pages. Have you attended a fantastic meeting? Send us some of the highlights for **Meeting Reports**. Have you done field work in, or taken a field trip to, an exotic place? Contact the managing editor about the possibility of publishing your adventures in **Travelogue**. You might want to share some outstanding images in **Parting Shots**. And finally, if your field of research is rapidly expanding and of interest to the *Elements* readership, consider the requirements for an *Elements* issue (www.elementsmagazine.org/proposal.htm) and propose an issue, or at least let us know you would like to read about such a topic. We are always on the lookout for exciting topics.

Pierrette Tremblay
Managing Editor

About Minority Participation

Sam Musaka's Triple Point article on underrepresentation of women and minority awardees in geoscience societies (volume 5, number 2, pp 77–78) was most important and timely, and I thank the author for addressing this issue. There is indeed a long way to go toward overall diversity in the geosciences, including medals/awards. Although I am a past recipient of the Clarke Medal and not of European descent, I am amazed that after over 20 years in this field I have seen so little change with regards to cultural diversity and minority participation at meetings and on research expeditions/cruises, etc. Women, on the other hand, have done much better (other than in the awards category), and Asian and East Indian geoscientists also seem to be making strides. International diversity is great and also important, but progress in this and in gender diversity should not overshadow or be perceived to address the continued lack of presence/participation of other groups, especially U.S. minorities (e.g. Native American, African American, Hispanic, Pacific Islander) in U.S. institutions! From my experience, this has not changed much and may have even declined for some groups over the past 20 years.

Ruth Blake
Department of Geology and Geophysics, Yale University

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racy and precision. There is an important place for data acquired by professionals in survey mode, and analyses by students are critical aspects of the learning process even though such data may not always be of high quality. I am arguing that we should not knowingly mingle those data with high-quality data in large databases. Nowadays, when X-ray diffractometers are compact enough to sit on desktops, when electron microprobes substitute for optical microscopes, when ICP mass spectrometers sprout like weeds and ion microprobes are in routine use, some gold standards for analytical data are needed. And other disciplines such as experimental geochemistry and field studies might also benefit from judicious oversight. Our science is just too important to be compromised by glitter. I hope more of our societies take up the challenge.

Hap McSween*
mcsween@utk.edu

* Hap McSween was the principal editor in charge of this issue.