Retraction

IN OUR REPORT ENTITLED "CORUNDUM, rutile, periclase, and CaO in Ca,Al-rich inclusions from carbonaceous chondrites" that appeared in *Science* on 31 May 1996 (p. 1316), we incorrectly interpreted single crystal electron diffraction patterns of oxide phases in Ca,Al-inclusions (CAIs) from carbonaceous chondrites.

CAIs found in carbonaceous chondrites contain refractory minerals such as spinel, melilite, fassaite, hibonite, grossite, and perovskite. In our 1996 report, we described the occurrence of submicrometer-sized oxide phases in these inclusions. Rutile, corundum, periclase, and CaO were identified in four CAIs from four different chondrites. The single oxide phases were identified by energy dispersive x-ray analyses and selected area single crystal diffraction patterns. After remeasurement of the electron diffraction patterns of the oxides, it was found that these assignments were incorrect.

Thus, the single oxide phases reported in the 1996 paper by A. Greshake *et al.* might be local contaminants or weathering artifacts, and any conclusions drawn from the occurrence of the single oxide phases are not valid.

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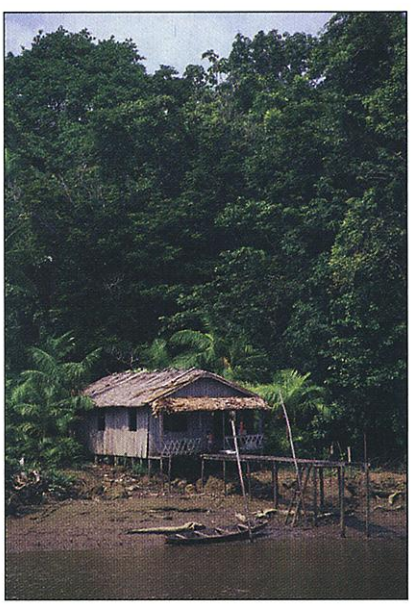
Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 6 months or issues of general interest. They can be submitted by e-mail (science_letters@aaas.org), the Web (www.letter2science.org), or regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Development of the Brazilian Amazon

IN THEIR DISCUSSION OF "THE FUTURE OF the Brazilian Amazon" (*Science*'s Compass, Policy Forum, 19 Jan., p. 438), W. F. Laurance and his co-authors offer a serious contribution to a very serious subject. Nevertheless, we reject their projections of extensive deforestation in the Brazilian Amazon.

The first difficulty is that they look 20 years ahead but extrapolate practices and events of 15 to 25 years ago. Today, Brazil is a fully functioning democracy. Gone are the days when public debate was shackled and development planning was a centralized, technocratic, closed-door process that produced non-negotiable directives and was dominated by geopolitical concerns. In fact, just the existence of the current debate about development projects, several of them scheduled for many years ahead, shows how much Brazil has changed.



Life in the Brazilian Amazon—what changes are in store after implementation of development programs such as Avança Brasil?

Second, the authors of the Policy Forum seem to deny that the Brazilian government can learn from the past, and they do not recognize the enormous changes of the last quarter-century. Brazil today has world-class environmental licensing procedures. Every major project must be evaluated by independent experts and discussed in public hearings, and recent legislation makes environmental destruction a criminal offense. Brazil uses satellite monitoring and other advanced technologies to observe and control rain forest development. Yes, enforcement is a problem, as in any country, but it is unreasonable to assume that past errors must necessarily be repeated.

Third, the full scope of the Avança Brasil development program goes far beyond the infrastructure projects Laurance and his co-authors mention. They wrongly suggest that Amazon development is a "top-down" process where projects are "approved long before the environmental costs and risks can be evaluated." In fact, Avança Brasil was preceded by a 3-year study led by international consultants and involving 100 experts from 18 Brazilian consulting companies and universities, including many nongovernment Amazon specialists. Preliminary results were debated in every state capital, as were numerous additional written submissions. A selection of the projects so identified was then incorporated into the Avança Brasil legislation sent to Congress and debated for 11 months. Even so, the government is commissioning supplementary environmental studies.

Finally, it is essential to understand that inclusion in Avança Brasil in no way diminishes the legal requirement for each project to undergo full, individual environmental licensing, as described above. If any project is found to present unacceptable environmental costs, it must be modified or shelved.

Nothing threatens the rain forest as much as poverty and ignorance. Some 20 million people live in the Brazilian Amazon region, most of them very poor. We must offer these people a lifestyle better than hacking and burning. That is what Avança Brasil seeks to do, by steering development toward the appropriate and sustainable use of each individual area through correct zoning.

Vast regions will be left untouched, as nature and Indian reserves. Others are appropriate for sustainable harvesting of forest prod-

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ucts. And some areas, but certainly a minority, are appropriate for agriculture. Laurance *et al.* rightly advocate intensive rather than extensive agriculture, favoring "high-value agroforestry and perennial crops," but they do not mention that various programs within Avança Brasil promote exactly that. Others foster biotechnology, ecotourism, and integrated local development, and dozens of programs in education, health, and sanitation seek to break the poverty circle.

Yes, the plan includes paving some existing highways, but no new ones will be added. And wherever possible, we will develop waterways rather than highways, because the environmental impact is much lower. Natural gas will replace oil-fired energy, thus reducing pollution and the demand for new hydropower, and projected dams are designed to minimize reservoir size and impact.

We are satisfied that the general directions proposed in Avança Brasil offer the best way forward. Nevertheless, we will continue to welcome and encourage the critical, informed participation of the Brazilian and international scientific communities in the awesome challenge and responsibility implicit in planning the development of the Amazon.

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d bates!

Discussion of the Policy Forum "The Future of the Brazilian Amazon" continues online in *Science*'s dEbates.

Response

SILVEIRA IS CERTAINLY CORRECT IN EMPHASIZING that Brazilian society is more open and democratic than in the past, and that the Avança Brasil program includes many provisions (such as construction of new schools, hospitals, and low-income housing) that would improve the lives of Amazonian residents. According to our estimates, however, about half of the total investments of Avança Brasil (over $20 billion) would be used for construction of major highways and infrastructure projects that are likely to have serious, negative impacts on Amazonian forests (*1*). Many of these megaprojects are mainly designed to support corporate soybean, logging, and cattle-ranching industries that tend to benefit major landowners and the wealthy, but have limited benefits for the poor (*2*). It was these projects on which our article focused.

Silveira suggests that there have been fundamental changes in Brazil that would substantially reduce the impacts of new highways, roads, and infrastructure projects on Amazon deforestation. In our view, little evidence supports this claim. Although there have been laudable improvements in Brazilian environmental legislation and public awareness, deforestation rates are still alarmingly high (*3*), and illegal logging and forest burning are rampant (*4*). In the past, highways and roads have dramatically increased deforestation, logging, hunting, and other degrading activities (*5, 6*), and this situation has not changed fundamentally. It strikes us as naïve to suggest that the Amazon basin could be crisscrossed by dozens of new highways and infrastructure projects and yet there would be little effect on forest destruction.

Silveira says that Avança Brasil will not create new highways, but this is misleading. About 7500 kilometers of existing roads will be paved (*1*). Paved highways greatly increase year-round accessibility to forests and urban markets and often cause sharp increases in forest exploitation. They also tend to generate extensive networks of secondary roads (*5*).

Hence, the "footprint" of forest destruction and degradation near highways is typically far greater than that of unpaved roads.

Finally, Silveira is correct in suggesting that Brazil has good environmental licensing procedures—on paper—but the implementation of these procedures has frequently been poor (*7*). Public hearings, for example, have rarely had much effect on the proposed projects, and many of the Amazonian experts to whom Silveira refers were employed by construction or consulting firms that tend to benefit directly from development (*8*). Until just recently, key agencies such as the Ministry of Environment have been virtually excluded from the planning process.

Our concern is that—given already enormous investments in resources and effort—the Avança Brasil program is becoming an almost unstoppable juggernaut. Environmental impact studies are slated to occur only during the final stages of planning—at which point individual projects have often gained enormous momentum. These studies rarely consider the indirect impacts of large-scale projects on forests (such as increased immigration and forest colonization), and their recommended mitigation measures are seldom adequate. Indeed, except for efforts such as those of the National Institute for Amazonian Research (5) and of the Instituto de Pesquisa Ambiental da Amazônia (*6*), there has so far been no systematic attempt to predict the impacts of the massive projects on Amazon forest loss and degradation. Moreover, land-use planning in the Amazon is fraught with problems; it is a hodgepodge of individual zonings by the nine Amazonian states, many strongly influenced by local resource-users and pressure groups (*9*).

In our view, the megaprojects of Avança Brasil present precisely the wrong vision for the Amazon. At present, only a small fraction of the Brazilian Amazon is fully protected (<4%, with a future target of 10%), and many existing reserves would become increasingly vulnerable to predatory logging, wildfires, and overhunting as new roads and highways draw near (*10*). Opening up vast new frontiers for colonization would encourage further immigration into a region that already is experiencing exponential population growth. It would also help maintain cheap land prices, reducing incentives for landowners to develop more efficient agricultural methods based on perennial crops rather than fire-based ranching and slash-and-burn farming. The megaprojects are also predicted to cause unprecedented forest fragmentation, and the resulting forest remnants will be much more vulnerable than intact forests to degrading activities in the future.

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Predicting Human Longevity

IN "PROSPECTS FOR HUMAN LONGEVITY," S. J. Olshansky and co-authors note that if the rate of mortality decline observed in France between 1985 and 1995 were to continue, life expectancy would reach 85 years by 2033 (average of male and female) and similarly in Japan by 2035 (*Science*'s Compass, Policy Forum, 23 Feb., p. 1491). They suggest that this represents an upper limit to the possibilities, unless scientists discover how to modify the aging process. Their corresponding calculation for the United States indicates that 85 would not be reached until 2182, a century and a half later. These long-run projections should not be based on such a short (10-year) observation period (*1*). For example, had they used the same method, but analyzed data for the most recently available decade starting just 3 years later, 1988 to 1998 (instead of 1985 to 1995), the United States would reach 85 years in 2052 rather than 2182, earlier by 130 years; extrapolation from 20 years, 1978 to 1998, gives a date of 2060. Life expectancy increased by 0.7 to 0.9 year (depending on data source) in just 3 years between 1995 and 1998, compared with a gain of 1.1 years over the entire decade 1985 to 1995. A more systematic approach to forecasting based on longer historical trends and more age detail suggests that a life expectancy of 85 would be reached in 2065, with a 95% probability range between 2043 and 2114 (*1*), indicating the high degree of uncertainty.


Ready or not, a long life awaits.

Analysts have repeatedly thought that death rates were approaching biological limits and could not fall much farther, only to be proved wrong by subsequent experience. The authors of the Policy Forum worry that continued decline at the long-run historical rates would reduce the death rates at ages below 30 to biologically implausible levels, and so constrains the infant mortality rate not to fall below 5 per 1000. However, 12 countries already report infant mortality below this threshold, with Iceland reporting 2.6. In any event, mortality below age 30 will have little effect on future life expectancy because it is already so low. Thus, infant mortality levels illustrate the perils in arguing that death rates at any age are near natural limits.

Olshansky and colleagues note that the Technical Advisory Panel recommendation that the Social Security actuaries raise their life expectancy forecast for 2075 by 3.7 years would require that death rates at each age decline twice as fast as "the already favorable rate of mortality decline projected by the [U.S. Social Security Administration]." This "favorable rate" projected by the actuaries, however, is only half the historical rate of decline (*1*). In fact, mortality decline at the historical rate would lead to life expectancy in 2075 that is higher by 3.7 years, as recommended by the panel. None of this is due to "ignoring the phenomenon of entropy in the life table," as the authors suggest. However, they are right that even this apparently modest increase in the life expectancy projected for 2075 requires continuing dramatic biomedical advances, which are implicitly assumed.

At several points, the authors qualify their predictions with phrases like "unless scientists can discover how to modify the aging process." Over the past century, science has made regular progress against disease and death, and given the dramatic biomedical advances for humans and other organisms in recent years, it would be risky to bet the long-term finances of the Social Security system on the assumption that this will cease. It is most prudent to assume that mortality will continue to decline on trend.

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Response

WE AGREE THAT THERE IS CONSIDERABLE uncertainty associated with demographic projections that extend far into the future, especially when those projections are based on an anticipated continuation of past mor-

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