

Africa Initiative for Planetary and Space Sciences

Imagine a group of academic subjects that could help Africa to inspire youngsters, spur innovation, develop local economies, solve pressing problems, and even foster regional peaceful coexistence. Can such a panacea exist?

We strongly feel that it can. The subjects? Planetary and space sciences (PSS). In many areas of the world, investment in planetary and space science kick-started a wave of technological development and interest in science that propelled countries forward. A survey of almost 800 researchers who published in *Nature* between 2005 and 2008 revealed that half of them were inspired by the Apollo missions to pursue science—and not just astronomy or planetary sciences [Monastersky, 2009].

To elevate planetary and space science across the entire African continent, we propose the Africa Initiative for Planetary and Space Sciences (AFIPS; <https://africapss.org/>), an idea that stemmed from a panel discussion during the planetary science sessions of the 35th International Geological Congress (IGC) in Cape Town, South Africa, in 2016. Here we list a series of recommendations for expanding and structuring PSS across Africa.

Why Focus on PSS in Africa?

Unlike their counterparts in North America, Europe, and Asia, African nations do not have large, dedicated PSS programs that have international visibility. If scientific output can be measured in publications, Africa produces less than 1% of the world output in PSS, despite having more than 15% of the world's population (see Figure 1 at <http://bit.ly/Eos-AfricaInitiativePSS>).

What factors cause this low rate? Most glaringly, several countries lack a critical mass of requisite experts in science, technology, engineering, and mathematics (STEM) subjects. In addition, there's a widespread misperception that funding fundamental science costs society a lot but has little or only long-term societal impact. Such thinking limits national or international investment in PSS in African countries, from primary school through university research.

But overcoming this obstacle offers many opportunities. PSS teams often involve physicists, chemists, geologists, biologists, and engineers working on a common problem.

This multidisciplinary aspect serves as a template for tackling pressing issues in our modern world.

What's more, expanding PSS may help to address several of the United Nations' Sustainable Development Goals that have already captured the interest of African governments: quality education, economic growth, reducing inequalities, climate, and peace.

PSS focuses on universal questions, such as the origin of life and the evolution and habitability of planets. Facts gained through science also help to fight against obscurantist tendencies. The subjects inspire people to think of the world as a single planet, not as a collection of countries. This favors international and intra-African cultural exchanges, which may contribute to peace alongside economic and social development.

What Does Africa Need to Foster PSS Education?

Students at most African high schools are not exposed to basic knowledge in astronomy and space science. We recommend a continent-wide effort to enhance teaching programs to fill these gaps.

Next, undergraduate students should be familiarized with the origin of Earth and other planets. The introduction to PSS should be the occasion to learn about the scientific value of the African impact cratering record and the wealth of scientific information gleaned from the numerous meteorites collected on the African continent.

Basic courses should include stimulating practical work, such as the analysis of planetary data and the examination of meteorites. Such practical courses require the creation and curation of meteorite collections in African museums.

From these courses should emerge opportunities to study space exploration techniques and become familiar with sensors used to analyze the surface and interior of planets. Pathways to research programs offered by major space agencies should also be cultivated.

To consolidate resources, the few African universities that already have emerging PSS groups are encouraged to commit to close interaction with key neighboring and overseas partners (universities and funding and space agencies). African students commonly move between countries and universities

with diverse curricula, and these PSS programs may attract highly motivated students from neighboring countries.

Filling This Need: The Africa Initiative for Planetary and Space Sciences

We propose initial investment for a 5-year program that prioritizes M.Sc. and Ph.D. scholarships, temporary study-abroad fellowships for M.Sc. and Ph.D. candidates, and visits of junior (volunteering Ph.D. students) and senior researchers to Africa for transfer of knowledge. After a fourth-year review, the program could be renewed for another 5 years, with the longer-term goal of building a 20-year plan.

Initially, students receiving fellowships should be selected in countries with emerging groups in PSS, and the research topics should be defined in relation to local expertise and scientific priorities. The program must be advertised to ensure that the local population and political authorities are able to grasp the outcomes of new groups of pioneering academics who will be moving Africa ahead.

The definition of research projects under this new effort should be based on local expertise and strengths.

Tapping into Africa's Wealth of Geological History

The African geological record offers fertile ground for understanding processes on other planets. AFIPS could tap into this record.

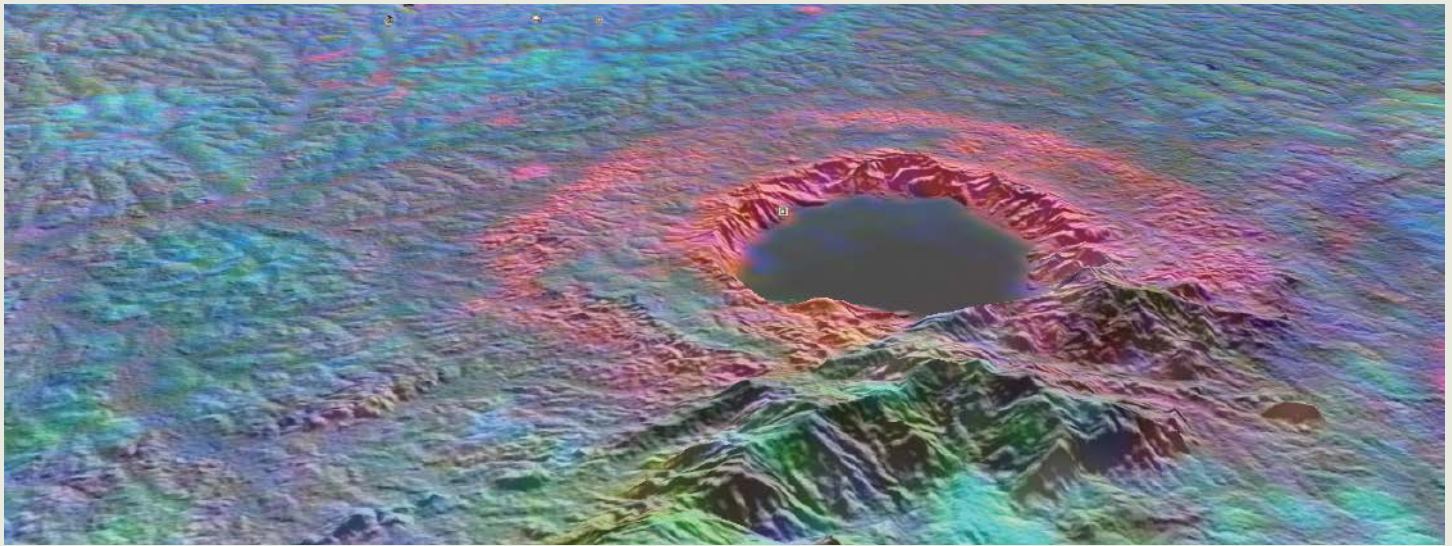
For example, planetary scientists have explored dry lakes in the Egyptian Western Desert to understand alteration signatures in the arid environment of Mars. Other planetary analogues include large meteorite impact structures, such as the Vredefort Dome in South Africa and the Bosumtwi impact crater in Ghana, and the active volcanoes and hydrothermal systems of the East African Rift. African deserts, in particular, the Sahara, are among the best places in the world to collect meteorites.

The African geological record extends for more than 3.5 billion years, with cratonic nuclei distributed throughout the continent, offering clues to understanding the coupled evolution of the interior, surface, atmosphere, and life on a habitable planet.

Science for Society

A key thread for AFIPS will be to harness PSS to help society. This involves not only pure research but also applied studies and conservation efforts.

Africa hosts 20 confirmed meteorite impact structures, including the largest and oldest on Earth (Vredefort, 2.02 billion years old). These structures, and specific sites therein, must be



False-color aerial view of Ghana's Bosumtwi impact structure showing surface enrichments of potassium (red), thorium (green), and uranium (blue) superimposed on a shaded relief image. The crater is about 10.5 kilometers in diameter and formed when a meteorite struck about 1 million years ago. Researchers hope to use geologic features like Bosumtwi to inspire the public and industries to become invested in PSS. Credit: David Baratoux/Geological Survey Department of Ghana

protected. AFIPS could be structured to show leadership in their conservation.

We also hope that through AFIPS, more African nations could take advantage of the clear night sky for observation of meteorite falls and of the dry conditions over a significant part of the continent for the preservation of ancient falls. We strongly feel that the curation of African meteorites in African museums for educational purposes will foster sustainable scientific and economic (tourism) development on local and regional levels, as well as contribute to education of the wider public.

We recommend that a regulatory framework be coordinated at the regional scale for efficient preservation of meteorites for scientific studies. It is our hope that through education efforts related to AFIPS, such coordination can be fostered.

Projects with implications for pressing issues (e.g., climate change and space environment) or a connection with industry will also be targeted by AFIPS. For instance, the study of shock deformation effects in natural impactites may serve the space industry, as it is related to the effects of impacts on man-made systems by micrometeorites.

Forging Partnerships

Academic staff training in PSS is a long-term effort. Here the Africa Initiative could mirror project frameworks of other science efforts in Africa. For example, Africa Array, a research and training program dedicated to continent-wide geophysics training that is run jointly by African and North American partners, is midway through a 20-year plan. The Africa Initiative requires a similar timescale.

Our initiative will build on the grassroots networks of African researchers, for example, the African Network of Earth Science Institutions, the African Academy of Sciences, the

Geological Society of Africa, the West African Exploration Initiative (WAXI; see Jessell *et al.* [2016]), and the Young Earth Scientists Network.

African networks may partner with geoscience societies. For instance, Europlanet, an organization with substantial experience in engaging policy makers and European citizens with planetary science, is already working with African partners to create a coordinated outreach strategy for activities related to the Danakil region in Ethiopia (as a planetary analogue site). Efforts in the Africa Initiative could follow this and other similar examples.

African institutions must be made more aware of the resources readily available to them. These include data released by NASA and European Space Agency planetary missions along with tools and tutorials on how to process the data. The rise of open-access journals offers African researchers greater access to the scientific literature, which will help future researchers on the continent.

Endorsing the Africa Initiative for Planetary and Space Sciences

It is our conviction that the exclusion of one fifth of the world's population from taking part in the fascinating discoveries about our solar system impoverishes global science. The identified benefits for African society as a whole justify investment in continent-wide research and education programs in PSS. This call is also timely considering the 31 January

2016 adoption by the African Union of the African Space Policy and Strategy, which raises awareness of the central role of space science and technology in Africa's socioeconomic development.

We declare our commitment to the development and expansion of PSS in Africa. Our effort will be focused on fund-raising and elaboration of international collaborative programs, coordination at the institutional level, training M.Sc. and Ph.D. students, organization of workshops and PSS sessions at Africa-based conferences, communication, and public outreach. Already, 19 international organizations, including AGU, and 257 scientists around the world have endorsed the initiative.

We will attempt to mobilize domestic resources for the implementation of this policy and strategy. We are looking for a broader endorsement from the international PSS community and from key stakeholders on the African continent. Individuals and national or international organizations who would like to support this initiative are invited to sign up on our website: <https://africapss.org/>.

References

- Jessell, M. W., et al. (2016), The West African Exploration Initiative—A case study in development geoscience, *AusIMM Bull.*, October.
 Monastersky, R. (2009), Shooting for the Moon, *Nature*, 460, 314–315, <https://doi.org/10.1038/460314a>.

Editor's Note: The authors of this sidebar are those who wrote the feature article "The State of Planetary and Space Sciences in Africa" (see page 16).