well as three positioners that will keep the segment properly aligned with its neighbors. South African astronomer Darragh O'Donoghue has revamped the optics that correct the spherical aberration caused by the main mirror's shape; the current image is 240% sharper and quadruples the field of view. With this "gigantic African eye," as President Thabo Mbeke has called it, SALT astronomers can search for planets orbiting nearby stars or probe distant galaxies for clues to the early history of the universe.

The South African government didn't put all its astronomical eggs in one basket. "We decided to look at the whole spectrum open to ground-based astronomy," says Adam. South Africa was approached in 1997 by an international consortium to participate in the HESS telescope, a high-energy gamma ray telescope in central Namibia. Gamma rays from space collide with atoms in the upper atmosphere, creating showers of secondary particles. These particles give off a faint blue light, Cherenkov radiation, which follows the path of the original gamma ray down to Earth's surface. Phase I of HESS, four 11-meter optical telescopes, will be inaugurated in September; the project may shed light on the mysterious origin of very high energy cosmic rays.

Currently, South Africa is in the throes of bidding to host SKA, a $1 billion international project to create a million square meters—1 square kilometer—of receiving surface for radio waves in the 0.15- to 20-gigahertz range. The vast surface, 100 times the size of the biggest receiving surface in existence, will consist of small antennas arranged in a dense core fanning out in an increasingly diffuse array extending as much as 10,000 kilometers from the central cluster, with some dishes on other continents. The widespread network will yield unprecedented resolution. Although the number, design, and distribution of antennas will not be finalized until 2007, the site for the core, an area that must be entirely free of cell phone, television, and radio transmissions, is expected to be chosen next year. South Africa has nominated three such sites in remote parts of the Northern Cape, SALT's home province. A half-dozen other countries are also putting in bids, including Australia, Argentina, and China.

But reservations remain about financing such projects when there are so many pressing problems in South Africa. "There is a sense that we should not be building [SALT], given the national challenges," says Khotso Mokhele, president of the National Research Foundation. "We're riddled with AIDS, multiple-drug-resistant tuberculosis, unemployment, crime—all sorts of things. And many people say, 'Why not take the money and respond to those challenges?' We say to them, 'Yes, we'll work ceaselessly and selflessly to respond to those challenges. But at the same time, we can still allow ourselves to see SALT as a project we want to fund.' "

Part of this commitment to big astronomy rests on the belief that the projects have tangible returns, such as spurring South Africa's economy and technological development. "People enjoy talking about dark matter, dark energy, and the big bang. And the science is exciting, but the more pragmatic side is, what will it do for South Africa?" says Justin Jonas, managing director of the Hartebeesthoek Radio Astronomy Observatory. So far, South African industry has made about 60% of SALT's components. And there are potential commercial spin-offs: Extremely fast switching devices used in HESS to detect rapid Cherenkov flashes are now being adapted for use in commercial sterilization systems, because such rapid switching generates ozone, a powerful disinfectant.

The big astronomy projects will also address another national challenge: improving science education in rural areas and among blacks. SALT's budget pays for a science teacher at the local high school in Sutherland, a teaching specialty that did not exist here until the new telescope came to town. And observatory staff members train teachers and give talks to children in other communities.

So while South African astronomers are gazing at the heavens, they are also working to solve problems closer to home. "We see astronomy as something driving the national development agenda," says senior astronomer Patricia Whitelock of the South African Astronomical Observatory. "It's not just astronomy, not just science for scientists. It's an icon of South African achievement, something young Africans can aspire to be part of." —CHARLENE CRABB

Charlene Crabb is a science writer based in Paris.

Earth Sciences Seek Niche Apart From Mining Industry

Powerful mining interests have long set the agenda for South African earth sciences. But perhaps not for much longer

CAPE TOWN, SOUTH AFRICA—Tshifhiwa Mabidi faces the same challenges as do graduate students everywhere, such as having a lot to learn in very little time. For her master's degree in geology here at the University of Cape Town (UCT), she is compiling a geological treasure map: an enormous database on minerals that she will use to test the predictive power of models used to zero in on precious metals such as gold, silver, and platinum. She looks over the computer algorithms she will soon have to learn how to use and grimaces. Before embarking up this mountain of learning, however, she's heading out into the field with a group of visiting German geologists to conduct magnetic and electrical soundings of Earth's crust. "It's completely unrelated to my master's thesis," she admits with a smile and a shrug, "but it will be a very good experience."

Solid future. Tshifhiwa Mabidi and many like her see a job in mining as prosperous and secure.

CREDIT: J. BOHANNON/*SCIENCE*

Such opportunities are a sign of the changing times as earth sciences departments try to cast off their historical role as a training ground for the country's powerful mining industry. The German team that Mabidi will join is part of an international project called Inkaba ye Africa that aims to transform South Africa's earth sciences community into a basic research powerhouse. "The problems that Inkaba is taking on are exciting," says Kevin Burke, an earth scientist at

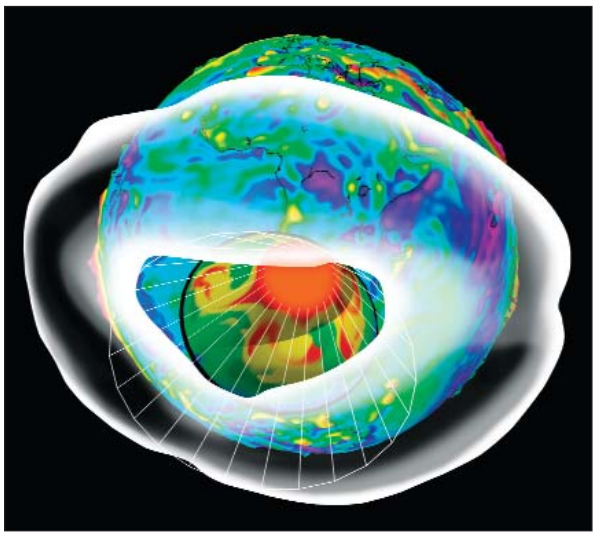
the Carnegie Institution of Washington. But Inkaba faces an uphill struggle: The mining industry continues to snap up the lion's share of top students, both black and white.

In a cramped office down the hall from Mabidi, her mentor, Maarten de Wit, is a blur of activity. He has just returned from a scientific meeting in France and is about to head out into the field with another German group. A geologist at UCT since 1989, de Wit has been South Africa's driving force behind Inkaba ye Africa. Since 2002 he has helped pull together 15 government and academic institutions in South Africa and Germany into a consortium. And Inkaba is more than just an idea now: The two governments signed up to the $14 million program in January.

The scale and complexity of Inkaba ye Africa are what set it apart from most earth science efforts. The plan is to survey a cone-shaped sector of Earth, extending from the core out to space and enclosing South Africa and much of the surrounding ocean. The idea is to uncover the evolution of its components —magma, rock, and water systems— going back 200 million years, when the Gondwana supercontinent began to break apart. The challenge is to explain how changes that have occurred deep beneath Earth's crust have influenced South Africa's current air, sea, and land features. That, de Wit predicts, should shed light on everything from the distribution of minerals and Earth's fluctuating magnetic field to the causes of climate change, natural hazards, and even human ancestry. In the Xhosa language—one of 11 spoken in South Africa—*Inkaba* means "navel" and figuratively conveys a sense of total interconnectedness.

So why South Africa? "Because it is, quite simply, the best natural earth systems laboratory in the world," de Wit claims. Brian Horsfield of the Earth Science Center (GFZ) in Potsdam, the main German coordinator of Inkaba, agrees: "The sheer magnificence of South African geology was the initial reason for the GFZ to set up shop down there." The bulk of the country's landmass consists of a chunk of crust called the Kaapvaal Craton that has remained stable for over 3.5 billion years within a shifting bed of younger rocks. As a result, de Wit says, southern Africa has "the longest and best-preserved geologic record in the world." Embedded in this island of stability are hundreds of kimberlites, magma pipes as many as a few kilometers wide that act like rock elevators, bringing samples from the lower mantle and perhaps even the core itself up close to the surface. People have been keenly interested in South Africa's kimberlites for more than a century because they are a rich source of diamonds. And South Africa's ancient geologic store is also one of the richest for gold and platinum.

Blasting in the world's deepest mines—some of which plunge 3 kilometers—has unexpected consequences. South Africa is now the only place in the world with anthropogenic tectonic activity, generating earthquakes up to magnitude 5 on the Richter scale across a 10,000 km^2 area—four times the size of Rhode Island—on an almost daily basis. By studying how fractures start and propagate through rock, Inkaba aims to improve mine safety and better understand the fundamentals of earthquake physics.



A slice of the action. Inkaba ye Africa will study in detail a cone of Earth's interior, surface, and atmosphere.

CREDIT: GICCES

But that is just the beginning. For example, one project is focusing on a hole in Earth's magnetic field drifting toward South Africa's west coast. Scientists are concerned that this anomaly could be a sign that the direction of Earth's magnetic field could be about to flip, as has happened several times in the planet's history. Because the field is generated by Earth's liquid core, Inkaba scientists want to discover whether it is due to an upwelling of magma at the core-mantle interface thousands of kilometers beneath South Africa. Normally, different kinds of earth scientists remain isolated from each other, says Hartwig Frimmel, a UCT earth scientist who serves as one of three Inkaba coordinators, but not in the Inkaba project. Because much of the data collecting will be done offshore, these geophysicists will be rubbing elbows onboard with geochemists and climate modelers working on an entirely different part of the Inkaba project.

For every section of Inkaba, money has been set aside to support black graduate students. This strategy for capacity building has already been tested on a smaller scale. Before Inkaba, de Wit and UCT geochemist Marian Tredoux were part of a project with several U.S. groups that focused on determining the geologic history of the Kaapvaal Craton. The initiative recruited several black students who have gone on to pursue basic research. Collaborations such as Inkaba have lasting benefits for black South Africans, says Tredoux, by giving them the chance to study abroad and work with Western counterparts. De Wit holds up a photo of his department's current final-year undergraduates and points out proudly that all but one of the 13 are black and half are women.

But how many of South Africa's black earth science students will stick with academia is another question. The UCT geology department recently advertised a faculty position explicitly for a black geologist. Despite the pool of talent on hand, says Frimmel, "not a single black applicant came forward." Part of the reason is a revolution taking place within the mining industry. As part of its black empowerment strategy, the government passed legislation in 2002 calling for at least 26% of the industry to be run by black South Africans within 10 years. To meet this demand, the industry is snapping up top black students by offering salaries with which academia can't compete.

Such career prospects tantalize students like Mabidi. The 23-year-old grew up in Venda, one of the "homelands" cordoned off by the apartheid government in the 1960s where blacks were forced to live in appalling poverty. She was lucky to move from her village to the town of Thohoyandou, the local capital, where she had access to education, including a geology degree at nearby the University of Venda, one of South Africa's historically black colleges. When asked what she will do after obtaining her master's degree, Mabidi does not hesitate: "I will almost certainly go into mining."

Tredoux isn't surprised. Many students "are sending money home to their families. I've found students nearly starving themselves to save," she says. Until there is a substantial black middle class in this country, says Tredoux, efforts at changing the color of the earth sciences faculty will continue to be "three steps forward, two steps back." But in the meantime, if Inkaba ye Africa achieves even half of its goals, the black Ph.D. students who do manage to avoid the lure of mining will find themselves in a golden age of South African earth science.

–JOHN BOHANNON

John Bohannon writes from Oxford, U.K.