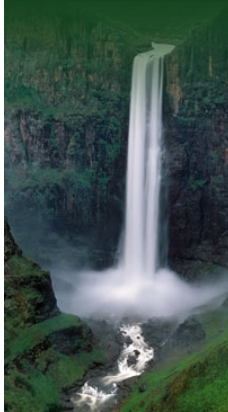


Orange-Senqu River Awareness Kit

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The River Basin

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Water Quality: Acidity, Heavy Metals and Radionuclides:

The Legacy of Gold Mining

Mining is one of southern Africa's most important sources of income. For more than a century, gold was the most important export commodity. This precious metal is still mined on the Witwatersrand, a rocky ridge running east to west and the site of Johannesburg. But over the past 20 years gold production has suffered a drastic decline. In 1970 South Africa was still producing a thousand tonnes of gold each year, two thirds of world production; but by 2010 this had dropped to just 192 tonnes, a mere ten percent of world production. As a contributor to the GDP gold mining has been overtaken by the booming platinum sector. South Africa today accounts for about 80 percent of the world's platinum production.

The Witwatersrand contains three gold mining areas, each of which is located in a so-called "basin". These basins, not to be confused with river basins, are underground geological formations that are separated from one another. Within each basin, water can find its way from one mine shaft to another.

In order to operate, sub-surface mining requires that the groundwater table is "drawn down" (pumped out) around the mine shafts to ensure that shafts don't flood and allowing the miners to operate their machinery. With world-leading techniques at their disposal, South Africa's gold mining industry managed to penetrate to depths of over 4 000 metres. But in the 1990s mines began closing. A major reason for the decline was that the cost of pumping groundwater was becoming prohibitively expensive. To ensure safe operating conditions, mines still in production often had to take on the water commitments of neighbouring mines that had closed. Today, hundreds of former gold mines in the Witwatersrand region are no longer operating. In many cases the former owners have absconded and their whereabouts are not known. Within the three basins of the Witwatersrand region, groundwater levels are gradually rising due to the increasing pressure on the remaining mines. Eventually the rising waters will reach the surface, flowing out in springs or seeping along riverbeds. In some cases this has already started to happen.

Acid Mine Drainage

The water emerging from the gold mines is polluted. Particularly undesirable are the large amounts of pyrite, or iron sulphide, which are associated with gold and coal deposits in South Africa and elsewhere. When pyrite, water and oxygen come into contact, they react and form sulphuric acid, which is highly corrosive. Further chemical processes follow, and these dissolve and release other metals into the groundwater such as iron, copper and manganese. They also liberate heavy metals including lead, cadmium, arsenic, mercury and uranium which is radioactive. Experts describe this process as "acid mine drainage" (AMD).

As the Orange-Senqu River basin includes numerous active and abandoned mines, the watercourses and surrounding riparian environment of the river basin is under significant threat from AMD. In the western Witwatersrand Basin AMD has been flowing to the surface since 2002. Each day, several million litres flow uncontrolled into rivers, dams and aquifers. In time, acid mine effluent will emerge from the central basin under Johannesburg and from the eastern basin too. According to a recent study performed by the CSIR in South Africa, the mining area around Gauteng has the potential to create 350 Ml/day of AMD - approximately the same volume of 140 Olympic swimming pools.

However, this phenomena is not new. In 1987, the United States Environmental Protection Agency (EPA) stated that after climate change, acid mine drainage constitutes the greatest environmental threat to the world. In many water bodies of today's South Africa sulphuric acid kills fish and reptiles.

Box: Acid Mine Drainage Defined

Mine drainage is metal-rich water formed from a chemical reaction between water and rocks containing sulphur-bearing minerals.

The runoff formed is usually acidic and frequently comes from areas where ore or coal mining activities have exposed rocks containing pyrite, a sulphur-bearing mineral.

Metal-rich drainage can also occur in mineralised areas that have not been mined.

Source: US EPA n.d.

Apart from this several hundred of mine dumps and tailings dams, each containing millions of tonnes of waste (ground and pulverised rock ranging in size from gravel to powder in consistency), are located along the long line of the Witwatersrand. They are exposed to the elements with winds blowing the finer particles away and heavy summer rains wash large quantities of acidic and radioactive particles into surrounding watercourses.

In addition to the direct impacts on humans and livestock, commercial interests selling fresh produce (fruit and vegetables) to the local and international markets have also expressed concern about the safety of future food production (Mail and Guardian 2010).

Interactive

Basin Map

Explore the sub-basins of the Orange-Senqu River

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Video Tour

Tour video scenes along the Orange-Senqu River related to the River Basin

[enter](#)

Geography Maps

Investigate land cover and terrestrial ecoregions in the basin

[enter](#)

Water Cycle

Examine how the hydrologic cycle moves water through and around the earth

[enter](#)

Food Web

Explore the interactions of living organisms in aquatic environments

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Mine tailings south of Johannesburg; although often carefully managed degrade over time, releasing acid and radioactive particles into the air and nearby watercourses.

Source: *Kruchem 2008*
(click to enlarge)

In the Eastern basin, even a Ramsar listed site is in acute danger – the Marievale Wetland Bird Sanctuary on the [Blesbokspruit](#). Every day the Grootvlei gold mine, which is no longer operating, discharges millions of litres of acid and uranium-rich mine water into the river. The waters are not purified, or if they are, the treatment is inadequate. Local authorities show no sign of enforcing the law. Visitors to the sanctuary describe seeing massive algae blooms, frogs with deformities and a drastic decline in the number of water birds.

Growing damage – but who will pay?

Much of the problem was caused by mining companies that no longer exist, so cannot be held accountable. Over many decades these corporations were allowed to use South Africa's natural resources to enrich themselves, without having to worry about the consequences in the future. When a gold deposit was exhausted, they simply closed and the company executives left.

Years after the problems began to become apparent, the government of South Africa introduced laws making organisations accountable for the long-term impact and maintenance of their mines. The result is that companies that closed mines after 1986 must bear the costs of comprehensive rehabilitation; however, the cost of dealing with older mines must be carried by the taxpayer of South Africa.

Unfortunately, this burden is only going to grow. There is a lot of dolomite and limestone in the Witwatersrand. In many areas of the Western basin, the acidic mine waters are now weathering away this rock and creating numerous new cavities and in some cases, destabilising rock formations near the surface.

One area under threat is the Cradle of Humankind, a valuable UNESCO world heritage site with countless ancient fossils that document the beginnings of human life on Earth. This site is located in a dolomite formation. If the acid seepage from the Western Basin seeps into the Cradle of Humankind site and the caves below, will begin to dissolve it.

There are also very real risks for the city of Johannesburg. In an interview with a researcher for this River Awareness Kit, Dr. Peter Ashton, of the CSIR, described how "much of Johannesburg is built on ridges. If water starts to rise underneath, it's going to find cracks and holes to decant north and south. But nobody has made in-depth studies of the likely consequences. If the water rises to certain levels and then decants, how is going to affect the structural integrity of the overlying rock? Will it collapse? Will it dissolve slowly?"

[Next: Coal Mining and water](#) ►