

The Effect of Chemical Contamination on Australian Gemstone Mines

Introduction: Coober Pedy is known as the "Opal Capital of the World" and is one of the largest sources of opals globally. The town and surrounding areas have extensive underground mining operations. The opal mines in Coober Pedy are the most notable Australian gemstone mines affected by chemical contamination. Opal mining in Coober Pedy involves extensive underground and open-cut mining, which can contaminate groundwater with heavy metals and other pollutants. The operation of machinery and explosives in mining activities can introduce chemicals into the environment, affecting water quality and soil health. The Old Timers Mining Company in South Australia is looking for a solution to chemical contamination and other pollutants around Coober Pedy.

Problem Definition: Chemical contamination from gemstone mines can pollute rivers, streams, and groundwater affecting aquatic ecosystems and the availability of clean water for fish consumption. Solving chemical contamination helps protect ecosystems, ensuring that they continue to provide essential services such as clean waters and habitat for biodiversity.

Data Sources:

Australian Government Environmental Data: Sources like [Geoscience Australia](#) and the [Department of Agriculture, Water and the Environment](#) provide data on soil, water quality, and environmental assessments.

Water Quality Data: Collected by local environmental agencies or monitoring programs. This can include data on pH levels, heavy metals, and other chemical contaminants.

Historical Mining Records: Available from South Australia's Department for Energy and Mining or the South Australian Resources Information Geoserver (SARIG).

South Australia Government Data Directory

Australian Marine Spatial Information System (AMSIS)

Geoscience Australia's Product Catalogue

Geoscience Australia Publications

Geoscience Australia Portal

Research Data Australia

Methodology:

Step 1: Set Objectives and Scope: Reduce contamination and restore aquatic ecosystems. Establish the geographic scope (specific mining regions in Ghana and Australia)

South Australia: Coober Pedy Opal Fields

Step 2: Data Collection: Gather Baseline Data: Obtain existing maps and satellite imagery of the mining regions. Collect historical data on mining activities and known contamination sites.

Step 3: GIS Mapping: Overlay Analysis: Perform spatial overlay analysis to identify contamination hotspots. Use GIS tools to model the spread and concentration of contaminants in water. The creation of concentric Buffers around a contamination source to analyze contamination spread and intensity.

Step 4: Visualization and Reporting: Create Maps and Dashboards: Develop detailed maps showing contamination levels, affected areas, and vulnerable ecosystems

Step 5: Mitigation and Remediation: Develop Mitigation Plans: Based on the GIS analysis, develop targeted mitigation strategies (e.g. water purification). Use visualizations to highlight trends and patterns over time

Step 6: Environmental Monitoring: Plan for field surveys to collect ground-truth data on contamination levels and environmental conditions.

Ongoing Monitoring using Field Surveys (i.e. ArcGIS Survey 123)

Evaluate Effectiveness:

Assess the impact of mitigation and remediation efforts over time

Analysis:

1. Then in ArcGIS Online (The Environmental Effects of Gemstone Mining in Australia), a web map is created showing the types of contaminants and areas of chemical spills.
2. ArcGIS Experience Builder- Analysis: Overlay Analysis was performed by combining multiple layers of spatial data from the environment, water bodies, and land use to identify the relationship between those layers and the areas of chemical spills. I also used Buffer analysis using the Buffer Tool in the Near Me Widget to allow the user (Environmental Lead) to place a buffer zone around areas with high concentrations of chemical spills.

3. The Field Worker pulled up ArcGIS Survey123 and called Environmental Incidents on his phone to report chemical spills and contact the Environmental Agency of Mining to monitor chemical contamination.
4. ArcGIS Dashboard called Mining Environmental Management is used by the Environmental Agency to provide real-time monitoring of chemical contaminants.
5. Validation: Ongoing Monitoring: Distributed Survey123 forms to field teams for ongoing monitoring of the site. Regularly collect and upload new data to track changes in contamination levels over time. Instruct Field teams to use Survey123 to collect water samples from different locations around the mine, heavy metal concentrations, and other contamination data.

Results:

1. ArcGIS Survey 123 Form: Distribute Survey123 forms to field teams for ongoing monitoring of the site. Regularly collect and upload new data to track changes in contamination levels over time. Instruct Field teams to use Survey123 to collect water samples from different locations around the mine, heavy metal concentrations, and other contamination data.
2. ArcGIS Dashboard: Pull in real-time data of chemical contamination using surveys from field workers, and environmental monitoring from Environmental Mining Agencies, displaying current contamination levels.