Potential Impact of Geothermal Water on the Financial Success of the Resolution Copper Mine, Arizona

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Lightning Summary

The unanticipated encounter of geothermal water in an exploratory shaft for the underground Resolution Copper Mine proposed by Rio Tinto will increase power requirements for mine dewatering and cooling by at least 24 megawatts, in addition to increased costs of ventilation and corrosion of equipment. The failure of Rio Tinto to estimate total power requirements and to seek any power source besides the local grid leads to serious questions regarding the profitability of the project.

Abstract

Rio Tinto has submitted a proposal to the U.S. Forest Service for an underground mine, called the Resolution Copper Mine, within a mix of federal public land (Tonto National Forest), Arizona state trust land, and private land. The proposed mine will be the largest copper mine in North America and will produce one billion pounds of copper per year. The objective of this study was to evaluate the ability of Rio Tinto to profitably operate the mine, regardless of the social and environmental impact of the mine. The objective was addressed by considering unanticipated costs, in particular, the encounter of geothermal water (180°F) in a 6943-foot-deep exploratory shaft at a flow rate of 1400 gallons per minute (gpm). The additional costs of mine dewatering and refrigeration were estimated using all best-case scenarios. The Thiem Equation for steady-state groundwater flow was used to estimate an entry rate for geothermal water of 3800 gpm for the completed mine. The Hazen-Williams Equation for pipe flow was then used to estimate a power requirement of 12 megawatts (MW) for dewatering. The theoretical maximum coefficient of performance for exchange of heat between the surface and the geothermal water was used to estimate a power requirement for refrigeration of another 12 MW. The minimum total power requirement for mine dewatering and refrigeration of 24 MW is equivalent to the average power requirement of 20,000 U.S. households. The worst-case scenario is difficult to estimate, but if more highly fractured rock is encountered during construction of the underground mine, the additional power requirements could easily be 100 times greater. Additional costs of ventilation, due to gases exsolving from the geothermal water, and corrosion of mine equipment, due to the persistent saturated atmosphere, were not considered. The most disturbing issue is the failure of the General Plan of Operations to estimate the total power requirements of the copper mine or to seek any source for power besides the local grid of the Salt River Project. Based upon the above concerns, it is not recommended that anyone invest in the copper project without clarification of power requirements and sources.

Projected Consumption of Electricity and Water by the Proposed Resolution Copper Mine, Arizona

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LIGHTNING SUMMARY

Rio Tinto has provided no estimate of the electricity consumption of the proposed Resolution Copper Mine, Arizona, but it can be shown to be 3% and 22% of the peak power capacity of the Salt River Project under the best-case and worst-case scenarios, respectively. Rio Tinto has estimated water consumption of only 15,700 acre-feet per year (about one-third of industry standards) while using conventional technologies for water efficiency.

ABSTRACT

The underground Resolution Copper Mine that is being proposed by Rio Tinto in Arizona would process 150,000 metric tons of ore per day from an ore body at a depth of 5000-7000 feet with a grade of 1.47%. The objective of this study was to evaluate the projected consumption of electricity and water by the proposed mine. Rio Tinto has provided no information about electricity consumption, except that power would be supplied by the local grid of the Salt River Project. Based on the depth, grade, and production rate, the projected electricity consumption would be 236 MW. However, the discovery of geothermal water while drilling the primary access shaft could result in additional electricity consumption of 24 MW solely for mine dewatering and refrigeration under the best-case scenario and 1650 MW under the worst-case scenario, corresponding to total electricity consumption of 260 MW and 1900 MW, which are 3% and 22%, respectively, of the peak power capacity of the Salt River Project. Rio Tinto has estimated water consumption as 15,700 acre-feet per year and a possible maximum of 20,000 acre-feet per year, with the Central Arizona Project as the primary water source. However, based on the grade and production rate, water consumption of 50,000 acre-feet per year would be more typical for the copper mining industry. Although Rio Tinto states that "the mine will be operated to maximize internal water reuse," the General Plan of Operations proposes only conventional technologies for water efficiency. These technologies would result in the export of cleaner tailings with 50% water, scavenger tailings with 35% water, and copper concentrates with 9% water, all of which are conventional industry standards. The export of water with the tailings alone would result in water consumption of 25,600 acre-feet of water per year. It is recommended that potential investors or partners seek clarification on the consumption and sources of electricity and water.

Evaluation of Predictions of Land Subsidence due to Panel Caving at the Resolution Copper Mine, Arizona

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LIGHTNING SUMMARY

The prediction by Rio Tinto that land subsidence resulting from panel caving at the proposed Resolution Copper Mine, Arizona, will not affect the sacred escarpment of Apache Leap is based on questionable mapping of geologic faults, the false assumption that subsidence is always slow, and a lack of any error bounds. It can be shown that the probability that the subsidence zone will reach Apache Leap is at least 5.3%, which is generally recognized as an unacceptable risk for the destruction of irreplaceable cultural or religious heritage.

ABSTRACT

The Resolution Copper Mine that is being proposed by Rio Tinto in Arizona would process up to 150,000 metric tons of ore per day from an ore body at a depth of 5000-7000 feet. The mining would be carried out using block caving, a type of underground mining that involves controlled cave-ins of overlying rock. Panel caving, the particular variation of block caving that would be used at the Resolution Copper Mine, divides the ore body into smaller panels that are mined sequentially. Land subsidence is a typical consequence of block caving. Rio Tinto has predicted that the maximum depth of the crater will be 984 feet, but that the subsidence zone will reach only 1500 feet from the sacred escarpment of Apache Leap. Rio Tinto has provided a description of the types of data used to predict subsidence, but not the actual data or the details of the modeling. The only exception is a map of the geological faults, which are the most important structures that transmit deformation. In that case, it can be shown from satellite imagery and aerial photography that the West Boundary Fault, which connects the footprint of the ore body with Apache Leap, was mapped in the wrong location with an offset of 2000 feet. Rio Tinto has described an extensive program of subsidence monitoring that relies on the assumption that "subsidence is a slow and gradual process that is predicted…and controlled." However, unanticipated subsidence occurs in 20% of block caving projects and the manual relied upon by Rio Tinto emphasizes the known risks of rapid subsidence and rockbursts. No error bounds have been provided on the limits of the subsidence zone. However, based upon the uncertainty in the prediction of maximum crater depth (coefficient of variation = 20%), the probability that the subsidence zone will reach Apache Leap is 5.3%, not taking into account any incorrect data used by Rio Tinto. By any standards, this is regarded as an unacceptable risk for the destruction of irreplaceable cultural and religious heritage.

Evaluation of the Maximum Design Earthquake for the Tailings Storage Facilities for the Proposed Resolution Copper Mine, Arizona

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LIGHTNING SUMMARY

The U.S. Forest Service has put forward five alternatives for the tailings storage facilities for the proposed Resolution Copper Mine, Arizona, all of which would be designed to withstand the 5000-year earthquake. However, since the failures of the alternatives would endanger the towns of Superior (population 2837), Queen Valley (population 820), Florence (population 26,074), and Dripping Springs (population 235), according to dam safety standards, they should be designed to withstand the Maximum Credible Earthquake, the largest earthquake that is theoretically possible within a particular seismotectonic setting.

ABSTRACT

The U.S. Forest Service has put forward five alternatives for the tailings storage facilities for the proposed Resolution Copper Mine, Arizona, all of which would be designed to withstand the 5000-year earthquake. Four of the alternatives (Peg Leg site, Skunk Camp site, and two at the Near West site) involve the storage of thickened tailings (50-70% solids), while one alternative (Silver King site) involves the storage of filtered tailings (86-89% solids). According to a wide range of dam safety standards, a dam for which the failure would result in the loss of human life should be designed to withstand the Maximum Credible Earthquake (MCE), the largest earthquake that is theoretically possible within a particular seismotectonic setting. Using a statistical model based on previous tailings dam failures, the runouts from the failures of the five alternatives would be in the range 200-370 miles. Although the flow potential of filtered tailings is less than that of thickened tailings, even if the failures of the dams for the filtered tailings caused only slumping of the tailings, they would travel at least 10,400 feet from the Silver King site, and would impact the town of Superior (population 2837) at a minimum distance of 2500 feet. The unincorporated area of Queen Valley (population 820) would be impacted by the failures of either of the Near West facilities (minimum distance 19,000 feet) or of the Silver King facility (minimum distance 8.2 miles). The town of Florence (population 26,074) would be impacted by the failures of the Peg Leg facility (minimum distance 10.3 miles), either of the Near West facilities (minimum distance 16.0 miles), or the Silver King facility (minimum distance 20.5 miles). The unincorporated area of Dripping Springs (population 235) would be impacted by the failure of the Skunk Camp facility (minimum distance 17,000 feet). Dripping Springs, Queen Valley and Superior are all well within what has been called the “self-rescue zone” in recent Brazilian legislation. On the above basis, the tailings storage facilities should be designed to withstand the Maximum Credible Earthquake, rather than the 5000-year earthquake that was proposed by Rio Tinto. It is recommended that anyone interested in investing in the Resolution Copper Mine should enquire as to the additional cost of designing for the MCE.