

NUCLEAR TECHNIQUES IN COPPER MINING (CHI/8/024) F5 New

MODEL PROJECT

CORE FINANCING

YEAR	Experts		Group Activity	Equipment	Fellowships		Scientific Visits		Group Training	Sub-Contracts	Misc. Comp.	TOTAL
	m/d	US \$	US \$	US \$	m/d	US \$	m/d	US \$	US \$	US \$	US \$	US \$
1999	0/28	13,720	0	70,000	3/0	10,350	0/0	0	0	0	0	94,070
2000	0/28	14,420	0	30,000	9/0	32,400	0/14	5,320	0	0	0	82,140

First Year Approved: 1999

OBJECTIVES: To improve copper recovery through an enhancement of ore selectivity and quality and to demonstrate the economic feasibility of determining the concentration of copper at various stages of exploration, mining and refining of copper minerals, using nuclear techniques such as prompt gamma neutron activation analysis (PGNAA).

BACKGROUND: Chile produces about 30% of the total world production of refined copper and possesses some 28% of the known world copper reserves. Copper is the country's main source of foreign exchange and as such its mining and export enjoys highest priority. The Chilean Copper Corporation (CODELCO), the country's main mining company, created the Institute for Innovation in Mining and Metallurgy (IM2) as its subsidiary in order to improve its ore processing technology, as it is experiencing growing costs. Due to increasing variability in the copper standard, better control is required at the various stages of the exploration, mining and processing of copper ore. IM2 will be assisted in the research by the Chilean Nuclear Energy Commission (CChEN). Nuclear techniques can be used for both borehole logging in order to improve selectivity, and on-line analysis on conveyor belt before the processing plant feed to allow a suited response of process control. A simulation of tool response has demonstrated that an accurate assay can be carried out for the major components of the ore, i.e. Cu, Fe, Si, Al, K, Na, S, and H. PGNAA is the only technique that can provide relevant information for copper ore grade determination, both for borehole logging and on-line analysis on conveyor belts. In Chuquicamata, the world's largest open pit mine, the copper grade will decrease within the next years, which suggests the need for the optimization of ore beneficiation. The Chuquicamata flotation plant is equipped with an off-stream analyser for process control, which has significantly improved ore recovery. Nevertheless, the variability of ore grade at the feed is very high. Ore grade variability can be reduced at the plant feed significantly if both borehole logging and on-line analysis before the flotation plants are carried out adequately. The PGNAA technique in borehole logging allows both a better selectivity according to cut-off and the improvement of ore mixing from the different panels to be mined. The PGNAA technique on-line analysis on conveyor belt provides an image of the pre-homogenization process and allows the plant to react early according to the measurements.

PROJECT PLAN: The major project activities will consist of design, calibration and testing of the PGNAA technique for copper ore analysis in borehole logging and on the cross belt conveyor. Since CChEN has equipment for borehole logging, it will carry out the tests. Designing and manufacturing a prototype will be completed in the first six months of the project, with the support of the Agency, IM2 and CChEN. The study will focus on both data processing and spectra calibration. Geostatistics for block assaying will be supported entirely by CODELCO. A cross belt analyser will be installed at a critical point of the processing plant for at least one year. In the first eight months, as well as the completion of the prototype, the technology transfer of PGNAA (i.e. the know-how for the production of analysers, calibration, training and maintenance) will be achieved. During 1999-2000, the project will build up the PGNAA systems adopted for cross belt and borehole logging measurements and also complete calibration and test operational quality and reliability. The validation of techniques will be completed at the end of project. The further full scale demonstration and routine service to end users will be continued beyond 2000.

NATIONAL COMMITMENT: The Chilean institutions involved in the project are CODELCO and its subsidiary IM2, and CChEN. IM2 is carrying out research and development in mineral industries, particularly in the copper industry. CChEN, where PGNAA was recently introduced through project CHI/2/014, will provide the nuclear techniques, particularly neutron induced reactions, electronics and Monte-Carlo codes for simulating neutron-gamma reactions, neutron and gamma transport. It has facilities for experiments with sealed radioactive sources and for borehole logging (natural radioactivity). The number and qualifications of counterpart staff at the three institutions are fully adequate and the requirements for laboratories, office space and experimental fields are met. Co-operation between the counterparts will ensure sustainability after the conclusion of the project. Sampling and chemical analysis requested for the calibration of the PGNAA technique will be supported by CODELCO end users. They will put their staff, facilities, laboratory equipment, mechanical and electronic workshops, and borehole operations at the disposal of the project. IM2 and CODELCO will contribute the chemical analysis requested for the calibration of the PGNAA technique, staff, facilities, laboratory equipment, mechanical and electronic

workshops, and borehole operations. CChEN will contribute a neutron source and borehole logging facilities for adaptation and calibration of PGNAA technique, pilot scale research, simulation and calibration. The country's contribution will reduce the implementation cost of these two PGNAA techniques from US \$400,000 (if it had to pay foreign companies for equipment and service) to US \$175,000 for purchasing the main components of equipment, training and expert services requested from the Agency. Hence, the country's contribution could be estimated at US \$225,000.

AGENCY INPUT: Expert services in PGNAA application; specialized training in design, calibration, testing and operation of PGNAA technique as applied to the copper industry; field equipment to complete the PGNAA system; training in the application of nuclear techniques in the mining industry, PGNAA borehole logging and operation, data processing, and simulation.

PROJECT IMPACT: The main impact will be the creation of a national capability to meet the country's needs in applications of nucleonic instrumentation, especially the PGNAA technique in improving copper recovery. The capacity and experience gained will be transferred to other copper ore mines and plants. The impact of the project will be felt by mid-2000, when the PGNAA technique will be operational for cross belt copper analysis, and when it will be put into operation for mining. The cost/benefit ratio for this kind of application, taking into account the copper recovery increase, should yield a benefit of several million US dollars per year.