

TITLE AND LOCATION (CITY AND STATE) AGUA NEGRA BINATIONAL TUNNEL ARGENTINA / CHILE		YEAR COMPLETED PROFESSIONAL SERVICES 2009 – 2011
PROJECT OWNER'S INFORMATION		
a. PROJECT OWNER Dirección Provincial de Vialidad	b. POINT OF CONTACT NAME Mr. Edgardo Merino (Eco Minera S.A.)	c. POINT OF CONTACT TELEPHONE NUMBER +54-264-4264305

RIZZO Associates executed the in-depth geological, geotechnical, and hydrogeological drilling studies for the feasibility stage of the Agua Negra Binational Tunnel. This Binational Project is now being fully developed in the surroundings of Agua Negra's border crossing, linking Argentina and Chile, through National Roads No. 150 in San Juan and No. 41 in the IV Region of Chile. This Project is located in the Los Andes Range, and consists of a double tunnel 14.5 km long. The Client is the Dirección Provincial de Vialidad (DPV) of San Juan, which by means of a Public Bid, the Contract was awarded to Ecominera SA and Rizzo Associates Argentina SA, with RIZZO being operationally responsible for the entire project and all of the tests.



The geology of the Front Range presents a complex stratigraphy, including metamorphic, sedimentary, and igneous rocks that evolved between the Paleozoic and Quaternary eras, and whose complete register is located in the Republic of Chile, west of the zone, where different alternatives of the tunnel design are projected. The geomorphology of the zone is characterized by the U-shaped valleys resulting from glacial erosion. The moraine glacial deposits from the Quaternary age are witnesses to the last glaciations in these valleys

CHALLENGES FOUND IN HIGH-MOUNTAIN AREAS: Given the height where works were developed, 4 to 4.8 km above sea level, the installation of different camps was necessary, four in total, two in each country. The mains camps were fully equipped for a permanent 50-person workforce to live and carry out its activities during the Project. On the operational sites, other strategic camps were set up and used for material storage, as a permanent communication center, and as a first aid center and shelter. These sites also had the necessary accommodations to provide lodging, and included satellite communication, water, food, dry clothes for staff, equipment, and heliport rescue capability, should any storm isolate them.

TECHNICAL PROJECT AND CHARACTERIZATION STUDIES: The Project required completing a total of 6.2 km of drilling and specific studies that are not usually carried out in Argentina due to the diameter of the required drillings (HQ 4") with total core recovery by means of NQ (63 mm).

GEOPHYSICAL PROSPECTING: In terms of the high demand of information required, RIZZO completed a program of measurements of borehole profiles and 3-D core rendering, using the latest technology relating to well-logging geophysics for small drilling diameters. Field equipment carried out the measurement of boring trajectories (gyroscope); measurement of the boring internal diameter (caliper); structure orientation and core reconstruction virtually by means of well acoustic and optical television sets; measurement of rock density (Gamma-Gamma) and porosity (Neutron-Neutron); lithology characterization and differentiation by means of Natural Gamma; measurement of water quality (pH, Temperature, Conductivity, Redox); and measurement of vertical flows (Flowmeter). The sonic log recordings allowed us to obtain complete wave and density along each borehole, and the 4 Dynamic Modules of the Rock Mass. This information was essential to develop the Geological profile and set the parameters of the modulation of the future tunnel design, since this quantitative-type information allowed us to predict the geomechanical behavior of rock masses, and was directly applicable to the engineering calculations, after making its geological interpretation.

GEOTECHNICAL STUDIES: Each boring has a continuous control in place. RIZZO personnel performed core control and handling tasks, RQD measurements, radioactivity measurement of each core sample, and routine pH, conductivity, temperature, O₂ and radon saturation on sludges, methane, CO₂ and radon gas at wellheads. RIZZO imported special equipment to carry out Dilatometric Tests on rocks at depths greater than 595 meters, which allows measuring the tension deformation values of rock, the "fluence" in the plastic deformation zone and the rock shear stress at the depths of interest.

HYDROGEOLOGICAL TESTS: RIZZO carried out different hydrogeological tests in each boring like Lugeon or packer test, hydraulic fracturing, short-term, long-term and step-drawdown pumping, drill stem tests (DST), slug tests, and repeat formation tests (RFT).

