Case History

Baroid Industrial Drilling Products

Torque Reduction using PENETROL® DRY
Petorca, Chile

Mine — Petorca—El Bronce (Can-Can Mining Co)

Drilling Contractor— Geotec SA

- **Project Objective**— Retrieve continuous core for geochemical assay work. Au/Ag/Cu data will be used to determine extent of mine expansion

- **Challenges**
  - Surface geology contains high reactive clay . Subsurface reactive tuff, unconsolidated sands and clay
  - Two adjacent holes abandoned due to fault induced collapse.
  - Contractor experiencing short runs, 25%+ core loss (wash out & disintegration, and caving.

Left: Petorca—El Bronce Chile

Right: Core recovery prior to fluid modification

Geology

The ore is localized in fault-controlled north-to-northeast-trending epithermal quartz veins and stock works of up to 20 m thick.

The mineralogy consists of free gold and gold-in-pyrite with chalcopyrite, sphalerite, galena, tetrahedrite and arsenopyrite in quartz/calcite/barite gangue. The ore occurs in lenticular vein bodies which strike north-northeast and dip east, and which are hosted by thick andesite sequences consisting of lahar breccia's, flows and tuffs belonging to the Upper Cretaceous Veta Negra Formation. Quartz diorite, feldspar porphyries and probable volcanic vent breccias pierce this sequence east of the main mineralized areas.

Fluid Design Considerations

Prior to arriving onsite the fluid was prepared bentonite and some filtration control polymers along with salt to serve as a clay inhibitor. A lubricant was added periodically. Figure 1 shows core barrel assembly back end coated in drill (clay) solids.

The goal of a revised fluid design would be to reduce the rate water sensitive solids (clay/tuff) from becoming entrained in the drill fluid. Reducing the rate of water wetting, both the formation and the core retain a better chance of maintaining stability. Improving stability of water reactive clay and tuff also reduces stickiness. Increased torque is often a function of entrained drill solids in fluid and stickiness of formation so maintaining better control of both variables improves chances success.

Figure 1. Core barrel back coated in drill solids. Fluid contains no QUIK-TROL GOLD, QUIKMUD GOLD or PENETROL DRY

Table 1. Revised Drilling Fluid

Drilling Fluid	
Soda Ash	0.5 Kg/1000L
QUIK-GEL GOLD	20 Kg/1000L
QUIK-TROL GOLD	2.5 Kg/1000L
QUIKMUD GOLD	1 Kg/1000L
PENETROL DRY	0.3-1.0 Kg/1000L

Table 1. shows the revised drilling design incorporating, improved fluid loss control (QUIK-TROL GOLD), clay stabilization (QUIKMUD GOLD) and PENETROL DRY to reduce clay stickiness and torque.

Fluid Mixing

Surface fluid capacity comprised three (3) 2000 L tanks. Makeup water was measured at pH 6 and hardness of 425 ppm. Soda Ash was added to water prior to addition of any drilling products to reduce hardness and raise pH. QUIK-GEL GOLD was blended until no lumps were visible followed by QUIK-TROLD GOLD and QUIKMUD GOLD. PENETROL DRY was added as needed based of water pressure and torque.

Target Fluid Properties	
Mud Weight	1.0 2 SG (8.5 lb/gal)
Funnel Viscosity	38 sec/qt
Plastic Viscosity	8 cps
Yield Point	6 lb/100 ft^2
Sand Content	<1%
pH	8.5 – 10
Total Hardness	< 100 mg/L

Drilling Plan and Operational Challenges

The adjacent table shows the drilling plan. The hole was being drilled HQ, but as a result of hole issues it was reduced to NQ at 211.05 m. Wet trips due to stuck inner tubes and early bit changes were recorded. Drilling torque and pump pressure were recorded at 2000 psi and 700 psi, respectively.

Drill Plan	
Hole Number	SMH-003
Inclination	-80^0
Target Depth	800 m
HQ casing set	211.05 m
NQ hole	351.35 m

A closer look at the existing drilling fluid properties helped identify some of the problems (Table 2.). The pH of the fluid was in the correct range of 8.5-10 however the hardness was elevated which can reduce the effectiveness of bentonite and polymer products. Fluid density in the suction end of tank was elevated (1.04 SG or 8.7 lb/gal) which indicates entrainment of drill solids.

The drill program was at risk as the daily production was reduced to 40%. At this point the revised drilling fluid was employed. The improved fluid properties in the revised fluid can be seen in Table 2 and Figure 2.

Table 2. Drilling Fluid Properties of Existing Mud and revised Mud

		Existing Fluid		Revised Fluid	
		Flow line	Tank	Flow line	Tank
pH		10	8	10	10
Hardness	ppm	250	425	50	50
Viscosity	sec/qt	38	31	43	41
Density	SG (lb/gal)	1.02 (8.5)	1.04 (8.7)	1.02 (8.5)	1.02 (8.5)
PV	cps	6	4	10	8
YP	$lbs/100ft^2$	4	3	8	8
Sand Content	%	0.4	0.7	0.4	0.7

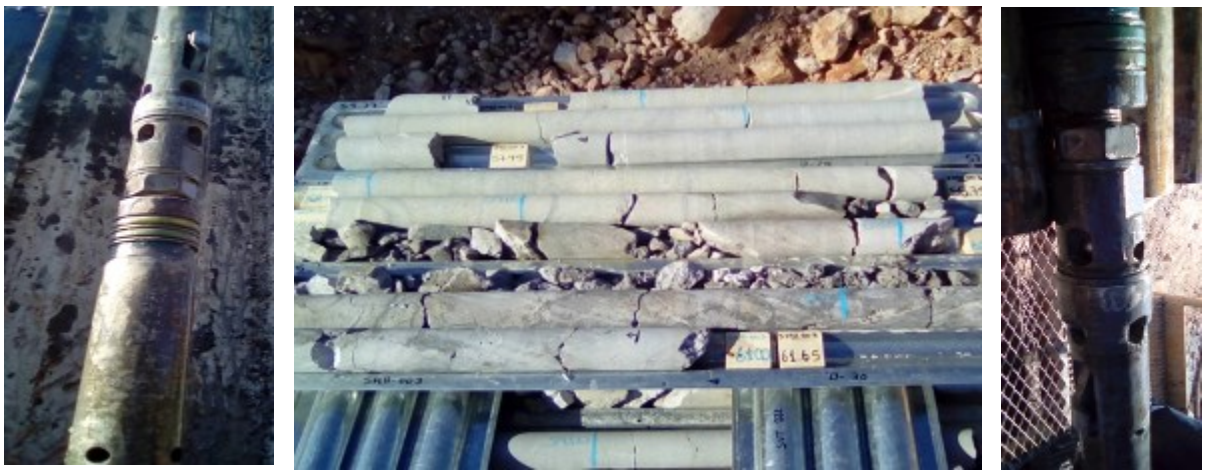
Figure 2. Revised Drilling Fluid with addition of PENETROL DRY

Drilling Performance

Day	1	2	3	4	5	6	7	8
Rod size	HQ				HQ-NQ	NQ		
m/day	33.5	53.5	40.6	56.6	20.3	43.6	19.2	21.4
Notes							Rods trip/stuck tube	

Day	9	10	11	12	13	14	15	16
Rod size	NQ							
m/ day	36.4	19.8	45.4	23.2	29	52.2	37.1	23.8
Notes		Rods trip/ stuck tube/ Bit change	PENETROL DRY addition	Rig mechanical shut downs				Bit change

Figure 3. Examples of Clean Core Barrel Assembly Back Ends and Core showing no signs of excess sticky solids following addition of PENETROL DRY.



Conclusions

- Addition of PENETROL DRY reduced sticking tendency of the drill solids to the inner tube and core samples.
- Sample recovery increased to 100% following fluid modification
- Torque (and vibration) reduced. Drilling with existing fluid average torque was 70 bar (~1000 psi) with peaks of between 100-130 bar (1470-2000 psi). Following addition of PENETROL DRY average torque 45-50 bar (660-735 psi). One peak over the six days at 60 bar (880 psi).
- 35% reduction in pump pressure. 50 to 30 bar (700 psi to 450 psi)
- 42% increase in bit life. Average increase in bit improved from 120 m to 207 m following addition of PENETROL DRY
- No rod trips or stuck inner tubes reported following addition of PENETROL DRY.

Left. Core Barrel Assembly without PENETROL DRY, **Right.** Core Barrel Assembly with PENETROL DRY