

UNZEN Scientific Drilling Project: Technical Evaluation of Conduit Drilling Result

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Unzen Scientific Drilling Project was great challenging operation that aimed at penetration into the core of the volcano 8 years after the eruption. This project had finished with success at July 2004. We drilled through the target center at 1700m measured depth, took cores 16 times included conduit of 1990-'95 eruption and drilled to 1995.75m total depth. For future scientific drilling, I try to evaluate this operation result from technical point of view.

1.Forecast of the hole problems before operation

At planning, we forecast that difficulty points of drilling were lost circulation, borehole instability, high temperature formation, kick, trajectory control, hole cleaning, coring and casing wearing. To avoid these troubles, we took below special measures, a) many casing stages included optional pipe, b) at shallow section, two step drilling as hole opening with bull nose after pilot drilling, c) special mud chemicals included aeration, d) TDS, EM-MWD, high pressure well head equipments and closed re-injection system, e) establishment of drill-safe subcommittee.

2.Actual results of troubles and solutions

(1) Lost circulation

At shallow section, lots of loss zone were encountered and could not be stopped above 400m by cementing and chemicals. Most effective measure was aerated mud considered as a last resort, because aeration is trigger of hole collapsing. Also we increased water supply in the same time. Fracture of Total loss at 807m caused thick cuttings bed, obliged us to set casing. Below this fracture, there was no trouble of lost circulation.

(2) Accidental side tracking

Above 260m, lots of accidental side tracking were happened in spite of using special B.H.A. This trouble was due to operation of build up angle in mix formation consisted of extreme soft unconsolidated zone and hard lava.

(3) Problems due to high inclination

Trajectory was attained almost on line of plan, except for build up in shallow section cause of accidental side tracking. Problem was only hole-cleaning trouble at 807m fracture.

(4) Other troubles

There was no trouble in borehole instability, high temperature, kick, coring and casing wearing.

3.Technical evaluation and suggestion for future scientific drilling planning

As compared forecast with actual result, it is roughly classified into three problem categories. First category is a) problems prevented or reduced trouble with adequate countermeasures by planning. It was lost circulation, kick, trajectory control, coring and casing wearing. Second category is b) unexpected problem with serious trouble. It was accidental side tracking. Third category is c) non-problem without countermeasures. It was borehole instability, high temperature. Since we could solve b) unexpected problem with re-planning of trajectory, validity of first plan was seemed well.

Reconsideration points are as follows, a) quick decision for aerated mud drilling, b) deeper K.O.P. c) attempting cementing at 807m fracture, d) attempting shallower target with continuous coring.

If pessimistic problems happened, each case estimations were as follows, a) 600 degree C formation temperature: drilling was possible, b) hole collapsing: drilling was possible in single problem, coinciding with other troubles occur serious bad condition, c) lost circulation around conduit: drilling was possible, d) kick: we could drill with closed re-injection system if hole condition was below 200 degree C and gas pressure was not high.

Except for technology, success factors were a) disclosing, communication and cooperation among scientists, engineers, government and local organizations, b) project manager and system ability that revising budget and drilling strategy at difficult situation, c) deep understanding and confidence between local people and project team. These factors are so important for any project.