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MEMORANDUM

To: Andrew Ryder ***Date:*** May 15, 2005

From: Roger Henneberger

Subject: Target Depth for Well MC-8

As requested, I have reviewed the results to date of the drilling of well MC-8. The review has been based on the daily reports and the mud log from the well, discussions with the mud logging personnel, direct observation of selected drill cuttings, and other sources of information as available. This memorandum presents a brief synthesis of the conditions encountered in the well so far, and a discussion and recommendation regarding options for completing the well (particularly with respect to the selection of a final depth).

Lithology

The lithologic units penetrated by MC-8 so far are generally similar to those found by MC-6 and MC-7, with differences that fall within the expected range of variation for the field. Probably the most significant difference is that MC-8 passes through about 200 m of rock logged as "felsite dike", from about 700 m to 900 m; the other wells found only small intervals of rock that was given this classification. It should be noted that, in all of the wells, rocks in this depth range tend to be fairly strongly altered, and it is possible that the same type of rock may be logged differently from well to well ("felsite dike", "altered intrusive", and "altered volcanics" may all be similar in appearance and subject to inconsistent identification).

Below about 950 m depth the rocks are almost entirely intrusive (and/or metamorphic), consisting predominantly of quartz diorite, "metasediments" (which are texturally different from the quartz diorite, but tend to be mineralogically similar in many respects), and several zones classified as "altered intrusive" (which, again, often appear similar to the quartz diorite).

It can be concluded that MC-8 is penetrating the same intrusive/metamorphic complex (possibly containing some sub-volcanic rocks) as the other MC wells. Some subtle differences in lithology (compared with MC-6 and MC-7) have been reported by the mudloggers. As an example, the quartz diorite in the interval now being drilled (below about 1780 m) is reported to appear more "brittle" than the similar rock found in the other wells. However, differences of this type are difficult to quantify, and it is even more difficult to determine if they have any significance as regards the nature and intensity of hydrothermal activity. In my opinion, the more significant observation is that the original lithology of the rocks found in the reservoir zones of the three

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new wells is more similar than different, and does not, by itself, provide any important evidence for differences in hydrothermal conditions between the wells.

The vertical distribution of rock units differs somewhat in MC-8 compared with MC-6 and MC-7, but this is not unexpected within an intrusive/metamorphic complex. Therefore, there is no definitive evidence regarding the presence or absence of structural offsets between the wells.

Alteration

Some significant differences in hydrothermal alteration between MC-8 and the other wells (particularly MC-6) have been reported. The mudloggers note with particular emphasis a much lower abundance of anhydrite in MC-8 within what appears to be the upper part of the reservoir zone (beginning near about 800 m). The mudlog shows, in general, a scarcity of secondary mineralization compared with MC-6 throughout the interval below 800 m.

My review of cuttings from MC-8 suggests that this apparent difference may be overstated. In particular, the interval from about 700 m to 1,100-1,200 m depth appears to have been affected quite strongly by hydrothermal activity, with pervasive deposition of well-formed coarse pyrite, and, possibly, significant replacement and/or recrystallization of rock components (parts of this interval appear silicified to me, but this is difficult to confirm because of the nature of the original rocks).

I conclude that the difference in alteration intensity between MC-8 and MC-6/MC-7 in the interval of 700-1,100 m depth is less than indicated by the mudlogs; in all three wells, this is an interval of relatively intense hydrothermal alteration and mineralization. The reported lack of anhydrite in MC-8 (particularly compared with MC-6) may be accurate, but it is unclear to what degree this is related to differences in original lithology vs. differences in hydrothermal activity. Detailed petrography (more than can be performed on site) would probably be needed to address this type of question.

Alteration intensity begins to decrease between about 1,100 and 1,200 m depth, and by about 1,250 m it has decreased substantially. The behavior of pyrite is especially indicative of this change: it becomes noticeably less abundant near 1,200 m, and decreases further in size and abundance with depth, until, by 1,700 m, it is nearly absent. This trend is not evident in the mudlog, but is quite noticeable when comparing cuttings from different intervals.

Alteration within the interval currently being drilled (from 1,600-1,700 m onward) is basically weak. The most visible secondary minerals in this interval are chlorite and epidote, both of which are more likely post-magmatic rather than hydrothermal. Overall, the rock in this interval does not indicate that much hydrothermal activity has occurred.

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Permeability

Indications of permeability in MC-8 are quite limited. The principal signs of permeable zones are some small mud losses in the interval of about 1,000 m – 1,250 m depth; none of these losses appears to have exceeded about 4 m^3/hr. Well MC-6 encountered roughly similar conditions in the same interval, whereas MC-7 had a more significant mud loss (of about 16 m^3/hr) near 1,000 m.

All of these indications of permeability in this upper zone within the reservoir are quite modest considering the intensity of hydrothermal alteration in this interval (which suggests pervasive water-rock interaction). Alternative possible explanations for this apparent discrepancy are (a) that the degree of permeability in this interval was greater in the past, but has been reduced by mineralization in fractures, and (b) that the alteration is the product of permeability that is very pervasive, but of limited magnitude (allowing widespread circulation of hydrothermal fluid through a network of fractures that are too small to create major losses of drilling fluid).

There are no significant indications of permeability below 1,250 m to the present depth of 1,845 m (a number of drilling breaks have been observed, but none has coincided with any noticeable loss of mud). Periodic drilling with aerated fluid may have obscured some minor permeable zones, but any major zones would have been noted regardless of the drilling procedure used.

The apparent lack of permeability in this interval matches the conditions observed in MC-6 and MC-7. In both of those wells, significant mud losses began to occur at deeper levels (near 1,950 m in MC-6, and near 2,100 m in MC-7). Some permeability also appears to be present in MC-1 at about the same level (near -500 m to -600 m elevation). There is no clear explanation for the occurrence of permeable zones at this level in the various wells; however, their presence gives some empirical evidence that similar zones might be encountered by MC-8, probably beginning around 2,000 m – 2,100 m depth.

Temperature

Circulating mud temperatures in MC-8 have been similar to those in MC-6 and MC-7. In the last several hundred meters the mud temperatures have been slightly lower (by a few degrees) in MC-8 than in the other wells; this is consistent with the expectation of slightly lower formation temperatures in this range of elevation. Overall, it is likely that the temperature regime is approximately as expected, and that temperatures in the reservoir zone are in the commercial range (that is, 220°C and greater).

From the present depth onward, it is uncertain (based on available temperature data from other wells) whether formation temperatures will increase slightly, decrease slightly, or remain

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approximately constant. The real trend of temperature change with depth will not be known until the well has been completed and allowed to recover thermally.

Discussion and Recommendation

To the present depth, the results of MC-8 have been within the range of expectation; that is, similar to the results of MC-6 and MC-7, without any major surprises. The interval of about 800-1,200 m depth which, based on the conceptual model of the system, corresponds to the upper part of the geothermal reservoir, appears to have been the site of substantial hydrothermal activity at some point, but does not exhibit major permeability now. If commercial production is to be obtained from this zone, it probably will have to be developed through some type of stimulation of the wellbore and surrounding rock (as appears to be the case in MC-6 and MC-7).

From 1,200-1,250 m to the present depth of 1,845 m, there is less evidence of hydrothermal activity, though the rock is probably hot. This zone is less attractive for production, though, again, the possibility of stimulation offers some hope. There is empirical evidence for anticipating that some elevated permeability (perhaps roughly comparable to that found in MC-6) may be encountered at deeper levels, between about 2,000 and 2,200 m depth. Therefore, it will be worthwhile to monitor the next 100 to 150 m closely for indications of permeability (such as increasing hydrothermal alteration).

Based on the results to date, and the current status of the well (and plans for upcoming well testing), a reasonable approach to drilling and completing MC-8 would be as follows:

- Continue deepening the well to at least 2,000 m depth, unless drilling problems prevent or significantly complicate this option.
- Consider terminating the well somewhere between 2,000 m and 2,200 m depth (the latter being the approximate nominal target depth) if indications of permeability are poor (no mud losses and no significant change in rock alteration). The exact depth selected might depend on drilling conditions.
- Continue drilling to the target depth (approximately 2,200 m) if conditions are good and there are signs of permeability (particularly mud losses). Consider drilling slightly deeper (perhaps 50 to 100 m more) if permeability appears to be increasing with depth (i.e. increasing mud losses near 2,200 m).
- There is little reason to drill deeper than 2,250-2,300 m, unless permeable zone of equal or greater magnitude to those found in MC-6 are being encountered.

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- Attempt to drill with aerated fluid if significant losses are being encountered. However, it is probably not worth investing a lot of time and money in this attempt if the air drilling is not working well.
- After drilling to total depth, displace the mud in the wellbore with water. As planned, leave the well without a liner.
- Set a program for completion testing based on the results observed (and on considerations for allocating the available budget to testing activities). Air lifting the well is probably not justified unless a significantly permeable zone (i.e. more permeable than anything found in MC-6) has been encountered. If it has been decided that the rig will move back onto MC-6 after completion of MC-8, then consider postponing all logging and testing of MC-8 until after the rig moves off the well, in order to save the cost of rig time (particularly overall permeability in MC-8 appears similar to that of MC-7).