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WATER QUALITY OF HGP-A WELL WATERS

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ABSTRACT

A water quality monitoring program of the HGP-A well was conducted for downhole depth samples and continuous discharge samples in 1976-77. The well water was slightly saline (about 5% ocean water) and nearly deplete of magnesium. But the water contained high concentration of silica and sulfide. The chemical composition of the well water did not vary much with depth even though the sample depth reached the well bottom located approximately 5800 feet below sea level. The well fluid temperature was higher than any Hawaii groundwater and recorded a maximum of 358°C (676°F) at the bottom of the well. The water was contrastingly low in tritium compared with the surrounding groundwater as close as 1 mile away, thus suggesting existence of possible geologic boundaries. During continuous flow tests, the total well yield was 76,000 lb per hour or equivalent to 150 gpm with 70% steam and the rest water. For most water quality parameters measured, there was a 1-3 day build up period before approaching a steady-state concentration. Coupling water quality data with other measurements, the well is judged either poorly developed or is located in a formation of low transmissivity. The moderately high rainfall and high surficial permeability allow substantial rain water infiltration. Actual subsurface water circulation is open to interpretation because of uncertain geologic formations. There are inferred existence of deep dikes or intrusive bodies located on the ocean side of the well and acting as barrier against sea water encroachment.

CONCLUSIONS

1. The water quality sampling program of the HGP-A well consisted of a series of 5 downhole water samplings at various depths under no-discharge condition, one similar sampling under very low discharge condition, and water quality monitoring of the discharge of the longest discharge test, March-May 1977. The median values for the downhole water samples are: pH<5, conductivity 3100 μmho/cm, salinity 2.3‰, chloride 925 mg/l, silica as SiO_2 420 mg/l, sulfide 100 mg/l, sodium 600 mg/l, potassium 123 mg/l, calcium 40 mg/l, magnesium 1 mg/l. Tritium value of 3 depth samples all shows less than 0.1 tritium unit, or at least 12 years old. The HGP-A well water is a slightly saline water and contains about 5% of ocean water. The well water has lost a small amount of potassium and nearly all of its magnesium when compared with diluted ocean water. This is probably due to subsurface geothermal effect. The well fluid temperature is higher than any Hawaii groundwater and recorded a maximum of 358°C (676°F) at the bottom of the well.

2. The HGP-A well fluid when discharged from the well, is principally a mixture of water and water vapor. Steam accounts for 66-70% of the mixture as computed from water chemistry data and confirming thermodynamics computations.

3. The concentration of all measured chemical quality parameters of the water under no-discharge condition did not vary much with depth even at the well bottom located 5851 feet below sea level. This suggests possible existence of deep dikes or intrusive bodies located on the ocean side of the well and acting as barrier against sea water encroachment.

4. The temperature and chemical composition data distinctly set off HGP-A well water from the surrounding groundwater, the closest measuring point being about a mile from HGP-A well. This fact when coupled with others, suggests probable areal size of the Kapoho geothermal reservoir.

5. During the flow tests, the quality parameters in the water discharge appeared to approach a steady state concentration after 1 to 3 days. The prolonged period taken before reaching steady state concentration suggests incompleteness of well development or low permeability of the formation or both. This observation appears to be consistent with the very low value of the computed formation. The reported transmissivity of 1 darcy-foot is about 5 order of magnitude smaller than that for normal productive Hawaii water wells that are of much shallower depth than HGP-A. The water discharge rate of HGP-A is small and on the order of 30 gpm although the total well discharge (water plus steam) was 76,000 lbs per hour or equivalent to 150 gpm.

6. During the January-February 15-day flow test, the concentrations of water quality parameters in the water portion of the discharge were: pH 8.5, conductivity 5900 μmho/cm, salinity 4.6‰, chloride 3600 mg/l, silica 135 mg/l, sodium 1300 mg/l, potassium 225 mg/l, calcium 80 mg/l. The total discharge fluid (a mixture of water and steam before separation) contained a lower concentration for the same water quality parameters except for silica. The steam quality computed by the water quality data on account of the separation process ranges 66-69% and is in close agreement with those based on thermodynamic data. A large amount of silica is

precipitated out while the acidic gases CO_2 and H_2S were lost to the steam phase, accompanying the pH increase in the liquid phase.

7. The geothermal effects on the fluid dynamics of the HGP-A well discharge, are profound as are known from other project data. It is interesting to reveal their hydrologic implications. For example, the build up of water level in the well was rising from about 900 feet below ground level 2 days after well shut-in to about 100 feet below ground level 22 days after well shut-in. This behavior resembles semi-logarithmic recovery in an artesian water well. The slowness of the rise is, however, not typical of artesian water well response but may reflect a condition analogous to leaky aquifer or may be caused by a combination of the incomplete well development already noted previously and the geothermal effects on the well fluid.

8. The moderately high rainfall (mean annual 125") and the high surficial permeability will create substantial rain water infiltration. The circulation of subsurface water whether it is infiltrated rain water or ground water transmitted to the Kapoho area is still open to interpretation because of uncertain geologic formation for the area. It is fairly certain that the Kapoho reservoir is in probably poor hydraulic communication with a saline water body of essentially ocean water composition in or surrounding the area. It is certain, however, that the ground water hydrologic regime tapped by HGP-A is distinctly different from the adjacent groundwater even as close as one to two miles from the well. The adjacent groundwater is known to be basal water directly recharged by contemporary rain water and mildly affected by geothermal sources as reflected by its warm water temperature.