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MRD

3.0 GEOLOGY AND GEOPHYSICS

3.1 Shallow Well Drilling Program

The drilling of shallow ($\leq$ 100 ft) hydrology wells of 0.14 meter (5-1/2 in.) diameter through the Raft River Narrows area has been completed with a total of 32 wells being drilled. Figure 1 shows the locations. The highest temperature encountered was 48°C (118°F) at the bottom two wells, one 30 ft deep, the other 40 ft deep, both located east of the Narrows. Though these shallow wells were intended to study the near surface water flow pattern, temperatures of this magnitude this close to the surface may indicate an escape of thermal water from a conduit between a deep geothermal reservoir and a shallow cold water aquifer.

Supporting the above hot water leakage hypothesis is the experience of the USGS in drilling of a well for additional hydrological studies. The well in question was drilled just north of the flowing BLM well 33°C (92°F). Originally drilled to a depth of 320 ft, the well had a standing head measured 7 ft from the surface. The "static" equilibrium temperature of this well was 90°C (194°F) at the 320 ft depth, indicating leakage of thermal water into the cold water system. Recently the USGS moved back onto the well site and drilled the hole to a depth of 407 ft when another interesting thermal water occurrence took place. While drilling this extension, the thermal water was passed at ~375 ft with colder water being encountered below this depth. The new static head was 21 ft below the surface. The change in water temperature does indeed indicate a mixing of thermal water with cold ground water along a leakage zone of the thermal conduit. The change in head between the two conditions is probably the result of water column density differences. Though no flowing or pumping tests have been attempted, several other mechanisms may be at work in this well--for instance:

1. The thermal water may have hydrothermally altered the sediments both above and below the warm water zone and pore pressure may have increased between these altered layers.

2. The dissolved solids themselves contained with the thermal water might be causing the warm zone to have higher pore pressure.

3. A lithologic difference occurring in the sediments occupied by the two zones may be having an effect on the pressure created within each of them.

The significance of these considerations for such a shallow well may be of more academic interest at present. Plans to flow and/or pump the well are being held in abeyance.

3.2 U.S. Geological Survey Studies

Additional geophysical surveys were conducted in late spring by the USGS for further understanding of the geologic and hydrologic picture of the Raft River Valley. The principal measurements were deep resistivity and refractive seismics. The resistivity profile was scoped initially using the random bipole method with one radiating point and several hundred detector positions. After brief analysis of that data, USGS then performed Schlumberger array (long line) measurements on selected lines of interest. The seismic measurements were made to determine major changes in refractive index. Large explosive charges, generally placed about 10 ft below ground level, were utilized.

To the north, at the lower end of the valley, the USGS is also doing extensive geologic mapping, to determine the structure in that area and apply this knowledge to understanding the overall geologic situation in the area. In recent years the use of microearthquake detection (-2 to 4 on the Richter Scale) has become a significant tool in the locating of geothermal areas. Currently the Colorado School of Mines is conducting a microearthquake study within the Raft River Valley. Using two single component geophones telemetered to the recording trailer and one three component geophone at the trailer, data will be recorded during most of this summer. The results of these geologic and geophysical surveys should be available by the fall

of 1974. A permanent microearthquake recording system will be installed in early fall prior to any deep drilling and withdrawal of geothermal liquids.

3.3 Intermediate Depth Wells

In order to gain a better direct understanding of the subsurface conditions prior to deep (approximately 2000 meters) well drilling, the USGS has been planning to drill serveral intermediate depth holes (typically 300 meters) of an exploratory nature, i.e., nominally 4 in. in diameter.*

The USGS held a full day meeting in Boise on July 10 to determine suitable locations for these holes. The morning was spent reviewing all the data available and making suggestions as to drilling sites and priorities. Although the resistivity and seismic data analyses were not completed with section plots, preliminary results gave an interesting outlook.

Low resistivity (ρ) could mean one of three things; 1) salt water, 2) clay beds, or 3) hot geothermal water. Salt water in this area is ruled out. Due to the large changes in resistivity at short distances indicating faulting, the clay beds are ruled out. Two areas of low ρ are of interest, a narrow N-S strip a little east of the Schmitt well turning at the Narrows road to follow the road several miles, and the second is a heart-shaped low ρ area (both on the order of 4 ohm-meters) south of Mrs. Crank's home in an E-W direction with the west lobe moving up towards the hot gravel pit. Some expressed the opinion that a very shallow hot water system may be leaking up from a N-S fault between the Schmitt well and the Malta Highway. The low ρ area south of Mrs. Crank's greenhouses is much thicker and somewhat deeper. *

A number of new gravity stations were added especially in the Narrows Area and south of Sheep Mountain. Little difference from the original gravity map is seen except near the mouth of the Narrows where a closed

* Information of a more complete nature is not yet available from USGS at the present time.

gravity high anomaly is indicated. The reason is unknown but may be an indication of a submerged dike across the Narrows. Aerial magnetics have verified several dikes east of the Narrows as well as basement at approximately the 6000 ft depth. (See Figure 1)

Age dating on some of the youngest lava flows in the Jim Sage range give ages of approximately 8.4 to 10 million years. The plug domes around and including Sheep Mountain and Round Mountain date approximately 7-8 million years. These ages are too old to be of any value for heat sources, themselves. Aluvium fans from Jim Sage date about 1/4 million years. However, predicted and located faults seem to intersect in the low resistivity areas and may be providing the conduits for either deep circulation sources of water or water from buried plutons.

USGS described the criteria for selection of the drilling sites as follows: (Listed in order of preference)

1. Center of Section 12, T15S, R26E. This hole west of bridge on the Narrows road would checkout the narrow low ρ strip. The interesting area will be about 800 ft deep, but plans are to drill to about 1200 feet.

2. SE 1/4 Section 15, T15S, R26E. The faulting in this area has been mapped. Low velocity seismic signals as well as inflection in gravity also indicates faulting. Drilling will verify this faulting near the edge of the low ρ strip.

3. NE 1/4 SE 1/4 Section 11, T15S, R26E. High ρ, high velocity area at this point will give contrast to the opposite geophysical values (give us an idea of what we don't want).

4. SW 1/4 Section 19, T15S, R27E. This area is in the low ρ heart shaped piece on private land, on which exploratory agreements are available.

5. In the Narrows Area, position not picked but would be in the closed gravity high area mentioned previously.

These locations are identified on Figure 2. The reasons for mid-depth drilling are to: 1) verify geology/geophysical models, 2) understand the geothermal system, 3) determine geothermal source characteristics, and 4) determine recharge-discharge characteristics of the system.

Petrological examinations have now been completed on the drilling chips supplied to Boise State University from the three wildcat oil wells* in the Raft River Valley. Results of these examinations as well as the drilling records, mud logs, and lithology logs will be used for information purposes in estimating the costs of drilling of the first deep geothermal test holes. The petrological examinations will continue as cores are made available from the mid-depth drilling.**

* The three oil and gas wells were drilled in the Valley, 10 to 25 miles from the suspected geothermal field, in the fall of 1973 and early summer of 1974 by a commercial gas exploration company. All wells have since been abandoned. One began to spout hot water three weeks after being abandoned. That flow has since been controlled.

** The petrological studies of the drill chip samples are being sponsored by the Idaho Nuclear Energy Commission. The intermediate depth drilling is to be supported in part by the Pacific Northwest Regional Commission.

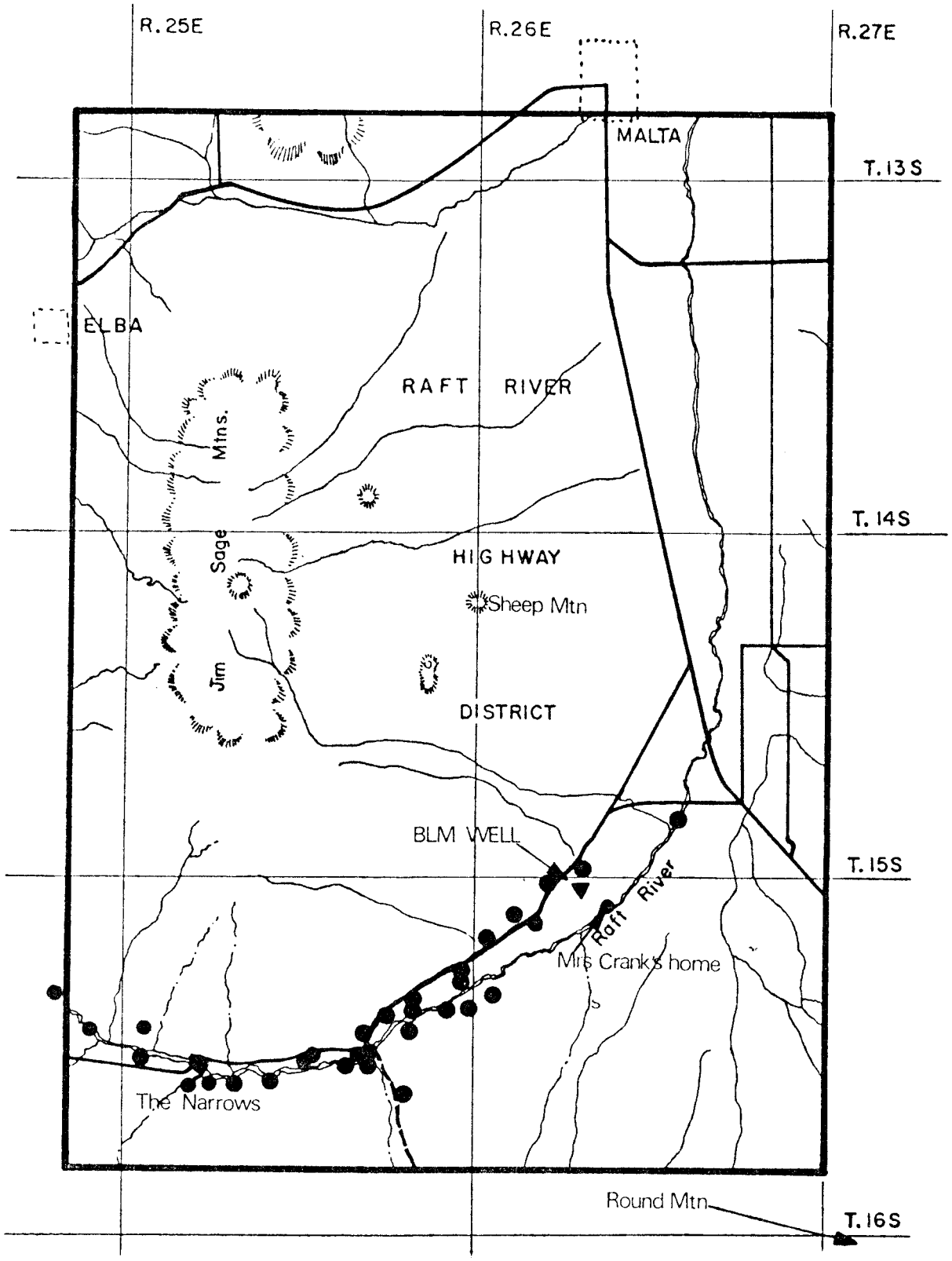

Fig. 1 Shallow Wells (various depths)

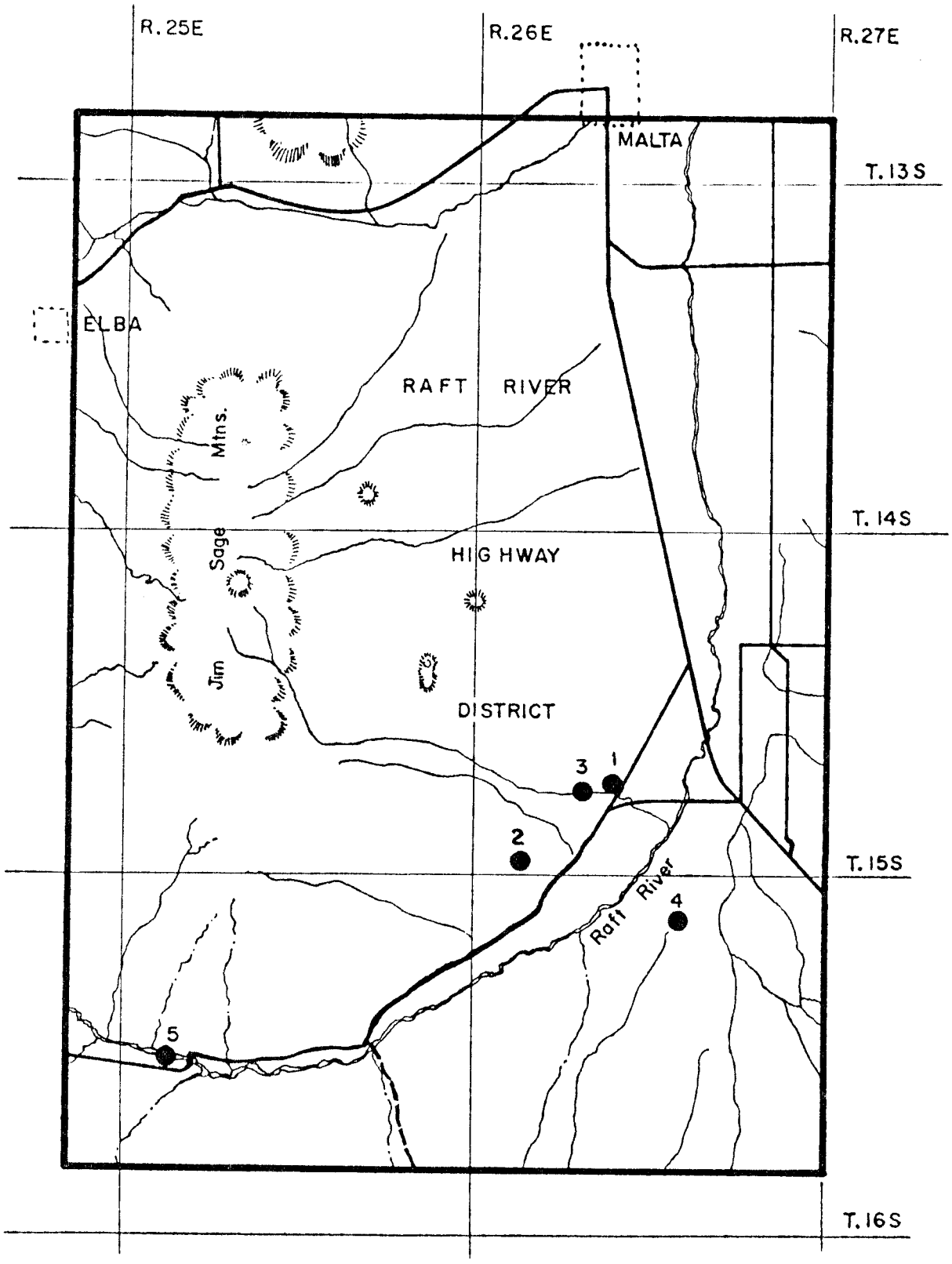

Fig. 2 Intermediate Cored Test Wells (approximately 1000 feet deep)
(wells numbered in order of their preference)