

**SUMMARY DESCRIPTIONS OF GEOTHERMAL CONDITIONS AT KWINIUK
AND PILGRIM HOT SPRINGS AND BENEATH KOTZEBUE, ALASKA**

NOTES FROM A 24-28 OCTOBER 2002 RECONNAISSANCE TRIP TO THE REGION

By

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Introduction

Between the dates of October 24 and 28, 2002, Gerald Hutterer, President of Geothermal Management Company, Inc. (GMC) traveled from Colorado to the Nome, Elim and Kotzebue regions in western Alaska. Mr. Hutterer was accompanied by Mr. Dennis Meiners of AIDEA/AEA in Nome and Elim part of the trip but he traveled alone to Kotzebue.

The purpose of the trip was to assess the potential for geothermal development at Quiniuk Hot Springs near Elim, at Pilgrim Hot Springs north of Nome, and beneath the town of Kotzebue. Special thanks are due to Luther Nagaruk, Elim Town Clerk, for arranging guide service and FWD vehicles with which to get to Kwiniuk, John Handeland of Nome for driving us to Pilgrim Springs, to Louis Green, the Pilgrim Springs caretaker, for guiding us around the geothermal wells at Pilgrim, and to Brad Reeve, Director of Kotzebue Electric Association, who totally facilitated the investigations at Kotzebue.

Presented below are summary descriptions of the geothermal status at each of the areas examined together with conclusions and recommendations regarding their development potential.

Elim and Kwiniuk Hot Springs

Elim is located 110 miles east of Nome on the shore of Norton Sound, an arm of the Bering Sea. Flight time from Nome via air taxi is about 1 hour; there are no roads into Elim. The population of Elim is about 309, virtually all natives. Their electricity is provided by a locally owned utility that runs three diesels capable of generating 585 kW.

Luther Nagaruk, the village clerk, is interested in alternative energy and has personally investigated the potential, for use in Elim, of wind, geothermal and hydro resources.

The only hot spring reasonably close to Elim is Kwiniuk. It is situated about 0.25 miles north of the Kwiniuk River, about 8 air-miles northwest of the village but about 15 miles (1.5 hours) via a moderately used, rough four-wheel-drive track.

The thermal springs flow from colluvium mantling intercalated meta-sedimentary rocks and quartz monzonite of the Derby pluton. The measured water temperature is 37°C (99°F), the pH is ~6.5 and the flow rate was estimated to be 4-6 GPM (64-96 L/m). There is some gas ebullition, probably CO₂, and a faint sulfur smell. The water was very clear with green algae lining the bottom of a shallow pool. There was no sign of carbonate scaling in the pool or on plastic pipes emanating from the pool. The latter were, at one time, installed to conduct hot waters to a small cabin near the spring. Unfortunately, in mid-winter, when temperatures reach -40°C (-40°F), the waters cooled too much to be of use for heating despite flowing through a 2 inch plastic pipe covered by 4 inches of foam all enclosed within a corrugated metal pipe.

There is no evidence at the site suggesting that this resource will be much hotter at depth than it is at the surface. The SiO₂ content is only 34 mg/l and there is no alteration or epithermal mineralization near the spring. It is likely that this spring issues from fractures in the Derby pluton near its contact with metamorphic bed rock and that the heat is derived primarily from circulation of ground waters to significant depths along these fractures.

Unfortunately, this spring is too cool, too small and too remote to be of any use to the residents of Elim except for balneology. Some exploration could be conducted to seek more fracture systems, but \$250,000 could easily be spent on geoscientific studies without finding more evidence of a hotter resource. Drilling, should it be considered, would cost a great deal as a helicopter, at \$650/hr., would be required to get a rig in place. Accordingly, further consideration of geothermal development at Kwiniuk springs is not recommended.

Pilgrim Springs

Pilgrim Hot Springs is located 53 miles north-northeast of Nome. It can be reached via the well-maintained Taylor Road, then by branching off onto a moderately well graded, second class road about 7 miles long that leads west and north to the vicinity of the upper Pilgrim River. Pilgrim Springs have been utilized since the early 1900's by local natives and by the Catholic Church. An orphanage was constructed, as were vegetable gardens and spa facilities. Currently, there remain the church building, the orphanage bunkhouse, several small cabins in various states of disrepair and one elevated hot tub. Louis Green, of Nome is the caretaker who grew up near the springs and who now periodically visits

the site and stays for several days at a time in his family's old house. The current owner of the property lease (from the church), on behalf of Pilgrim Springs Corporation, Inc., is Mr. Arthur Neuman, an Alaskan attorney now living in Washington, DC.

At the site of the original springs, six wells were drilled in search of geothermal resources. The work was done in 1979 and in 1982 using Alaska State funds. The wells penetrated a thermal aquifer containing waters with temperatures that range from 87°C (188°F) to 46°C (110°F) to 14°C (57°F) in wells PS #1, #4 and #3 respectively; the pHs measured in these wells were 6.6, 6.0, and 5.5 respectively and their respective flow rates were estimated at 12, 20 and 30 GPM (192, 320 and 48 L/m). Wells designated PS #2, MS #5 and MI -1 (Mary's Igloo - 1) were capped.

The wellheads were all severely rusted and showed signs of acid degradation. Calcite scale was fairly thick on the wellheads and on attached pipes. The hot tub was floored by green algae and the stream of 46°C (114°F) water piped into it was under an artesian head of 7 feet.

It appears as if Pilgrim Springs are located along a major east striking regional structure that controls, from northwest to southeast, the northern shore of Grantly Harbor, the Imuruk Basin, the course of the upper Pilgrim River, the pass between the Bendeleben and Kigluaik mountains, the course of the Niukluk River and the shape of the northeastern shore of Golovin Bay. It is likely that this structure comprises numerous sub-parallel, well developed faults and that at least one of them is a source for the Pilgrim Springs thermal waters. Examination of the geomorphology of the region suggests that there is also a north-northeast trending structural grain. It seem quite likely therefore, that Pilgrim Springs may rise at or near an intersection of these orthogonal fracture systems.

The results of exploration drilling revealed that a highly permeable, 50 foot thick, subhorizontal aquifer, about 70 to 120 feet below the ground surface, underlies the thermal area and that below 120 feet, water temperatures cool rapidly. What is not precisely known as a result of the exploration work conducted to date, is the location of the upflow zone feeding the horizontal aquifer. In light of the artesian conditions, this feeder is postulated be located to the west or north of the springs.

Geochemical analyses of produced waters suggest that equilibrium temperatures may be at or slightly above 150°C (300°F). This temperature would be high enough to support power generation using binary systems and if adequate permeability were to be confirmed, a 5-10 MWe project could be considered. Because of the distance to Nome, the only logical market for geothermally generated power, this size project might be a minimum to permit development of an economically viable scheme.

Pilgrim Hot Springs already has excellent potential for direct use of the geothermal resource. Greenhousing, space heating, timber drying, and/or aquaculture are among

those that appear to be eminently feasible and which should be promoted. Creation of a spa like Chena Hot Springs may also be possible and might be an attraction to Nome residents and cruise ship tourists.

This prospect is still attractive despite discovery of the temperature reversal at 120 feet. Fracture location would be the next exploration objective, so that seismic, self-potential and possibly gravity, soil radium or soil mercury surveys might be employed. Approximately \$250,000 should be budgeted with anticipation that more drilling would then be required to confirm any interesting geophysical or geochemical findings. **The expenditure of funds of this order of magnitude needed to identify the thermal upflow zone is strongly recommended.**

Kotzebue

The city of Kotzebue has a population of about 4,000, has a first class airport, and is a major trading center for northwestern Alaska. An 80,000 square foot hospital, a college, several lower level schools, municipal buildings and native corporation buildings all occupy the west central part of town. The climate is severe, despite Kotzebue's location on Kotzebue Sound (an arm of the Bering Sea) with more than 16,000 heating degree days and mid-winter wind chill factors that can approach -130°F !

Kotzebue has been built on the western tip of the Baldwin Peninsula. It is separated from the mainland by Hotham Inlet to the north and by the main part of Kotzebue Sound to the south. The peninsula is underlain by about 2,000 feet of Tertiary age sediments, predominantly clays, silts, sands, and gravels deposited by the Noatak and the Kobuk Rivers or their ancestors. The Kotzebue area is above a basement high in the western part of the Sewalik Basin, near where it joins the Hope Basin. Basement rocks include metamorphic, carbonate and volcanic units that outcrop in highlands located to the south of Kotzebue Sound.

In two deep (6,000+ and 8,000+ feet) petroleum exploration wells drilled by Chevron to the northwest and southeast of Kotzebue, unequilibrated bottom hole temperatures in excess of 72°C (160°F) were recorded together with thermal gradients of 1.7 to $2.5^{\circ}\text{F}/100$ feet. If these gradients are used to estimate water temperatures at the contact of the Tertiary sediments with basement rocks about 2,000 feet beneath Kotzebue, they would be from 42°C (107°F) to 71°C (160°F), slightly cool, but adequate for use in a district heating system. *It should be noted that equilibrated temperatures in the referenced wells would probably have been about 10°C (18°F) higher than those listed above.*

There may also be evidence for the existence of waters at this temperature as shallow as 300 feet beneath Kotzebue. Mr. Frank Stein, a local resident claims to know of a well that penetrated such a resource in the 1950-1952 era. This lead is being pursued by contacting several other professional persons and jurisdictional entities believed to be familiar with

events in Kotzebue in those years. Among those to be interviewed for confirmation of this information are the Public Health Service in Anchorage, the Bureau of Indian Affairs in Juneau and four individuals identified by Mr. Jay Farmwald of Anchorage.

If 1,500 GPM of 82°C (180°F) water could be produced from shallow wells drilled in the vicinity of the building complex previously mentioned, there is a strong possibility that a technically and economically viable district heating system could be built. Studies utilizing the information from the Chevron wells were conducted in 1979 and 1980 and recommendations were made to take the studies further. The reasons why this project was not pursued will be identified. **At this time it is highly recommended that GeoPowering the West resume the studies that were abandoned in the earl 1980s with creation of a Kotzebue geothermal district heating system as the ultimate objective.**