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THE USE OF GEOTHERMAL FLUIDS TO HEAT A LARGE GREENHOUSE COMPLEX

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ABSTRACT

Geothermal fluids are being used to heat 30 greenhouses near Susanville, in Northeastern California. Cucumbers and tomatoes are grown in a hydroponic system requiring no root medium such as dirt or gravel. A high quality ground water supply is used for irrigation, while a shallow geothermal well supplies hot water for the heat-exchange type heaters. Thermostats and humidistats control the greenhouse environment. Nutrients are supplied in the irrigation water circulated through the root system that is contained in polyethylene growing tubes. A high quality fruit is produced and sold in the Los Angeles market. The complex has been planned for expansion to 205 greenhouses, and the next units are scheduled for construction this year.

HYDROPONIC VEGETABLE CULTURE

A large greenhouse complex is producing vegetables in a controlled environment with all heating requirements supplied by geothermal fluids. In Northeastern California, near Susanville, GeoProducts Corporation of Oakland has installed the first 30 greenhouses of a planned 205-greenhouse complex.

The greenhouses utilize hydroponic growing techniques to produce a high quality produce - currently tomatoes and European cucumbers. The plants - about 850 per greenhouse - are grown in flexible polyethylene growing tubes. There is no growing medium such as dirt, gravel or peat moss; instead, the plant roots are enclosed in the tube with the plant stem protruding from a pre-cut slit. The plant is supported by twine extending from an overhead support grid. As the plant grows, it is pruned to leave only one main stem, thereby concentrating the plant's strength in the budding area where the fruit develops.

Each greenhouse has two 450-gallon fiberglass tanks buried under the concrete floor. A nutrient solution is maintained in this reservoir and periodically pumped into the end of each growing tube. The nutrient solution flows through the tube by gravity and drains back into the nutrient reservoir. Water for the nutrient solution is supplied by a near by cold-water well producing from 110 feet. The well is not contaminated by geotheraml fluids and produces an excellent quality water. The system uses very little irrigant water - only about 10% as much as row crop systems.

HEATING AND COOLING

The greenhouses are in an area of high temperature variations from summer to winter. Summer temperatures exceed 100°F several times a year and winter temperatures reach-20°F. Elevation of the site is 4000' and average percipitation is only about 6", so evaporative cooling provides excellent summer cooling. Winter heating is provided by two off-the-shelf heaters with copper coils. Geothermal water at about 190°F is circulated through the coils and a fan forces air across the coils and into a series of polyethylene convection tubes. The convection tubes are perforated, and carry the heated air to all areas of the greenhouse to maintain the desired temperatures.

Hot geothermal fluid is pumped through the main supply lines and into the heating coils by a 40hp. turbine pump. A motorized valve at each heater controls the rate of flow required to maintain the greenhouse environment. The valves are controlled by thermostats which are adjusted vertically to match approximate fruit levels. During coldest periods, each greenhouse is designed to use about 10gpm of 190°F geothermal fluid with a system pressure of 25 psi. Effluent from the heaters leaves the greenhouses at 120° F and flows into an existing drainage ditch where the site's rancher allows his range cattle to drink it. Eventually, it seeps underground and into Honey Lake, an alkali sink devoid

of aquatic life which drains the entire valley.

GEOTHERMAL SYSTEM

The geothermal resource is derived from an underground hydrothermal system believed to be heated by a deep-seated magma chamber. Volcanism of Pleistocene-to-recent age exists near the site, and the area's abnormal heat flow can be traced to this source. While the main reservoir is believed to be as deep as 5000 to 6000 feet, the hot fluids circulate to shallow zones through an extensive fault system. Where the intruding geothermal fluids intersect a ground water zone, mixing occurs and the shallow water wells drilled in these areas might encounter water zones varying from 68°F to boiling temperatures. Where the faults intersect the surface, hot springs exist, often at boiling temperatures.

Geothermal fluid for the greenhouses is supplied primarily from a shallow (627') well drilled into a fault through which the hot fluids are escaping the deep hydrothermal system. The hottest zone in the well is at 100 feet, where 216°F has been measured. Average temperature at the bottom of the pump setting (200') is 210°F. The well is pumped with a turbine pump designed by Valley Pump Company. About 300 gpm of geothermal fluid is supplied to the greenhouses during peak periods. The hot water is pumped to the greenhouses through 175 feet of transite line buried 36 inches without insulation.

MARKETING

The cucumbers are individually wrapped and individually labeled, as are the tomatoes, with the company's logo, Honey Lake Farms. Marketing is done through a large produce broker in Los Angeles. The fruit has excellent taste and visual qualities and an unusually long shelf life with virtually no loss from spoilage. Market demand for the produce has been excellent even though prices are well above the prices received for field crops. Expansion of the complex is planned to begin this summer in units of 25 greenhouses.

View of GeoProducts greenhouses near Susanville, California. This is the first 30 of a proposed 205 greenhouse complex.

Interior of a GeoProducts greenhouse near Susanville, California, planted with tomatoes.