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GEOTHERMAL ENERGY AND THE FOOD INDUSTRY, SOUTH LOUISIANA

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The general public reaction to the word "geothermal" is to immediately envision the Geysers, Old Faithful and sometimes from press and magazine articles, to associate geothermals with power generation. Seldom however has consideration of food processing been associated with this energy medium.

From our investigations at de Laureal Engineers under ERDA contract the potentials for food preparations and processing in Louisiana have been under considerable scrutiny.

We have learned that may food processes are compatible temperature-wise with the indicated temperatures available from Geo-Thermal well water.

As we are now aware there are large geopressured aquifers both onshore and offshore abounding the Texas and Louisiana coasts. These georesources are abundant in quantities of hot saline water, dissolved methane and, due to the relative high pressures of the formations, significant amounts of hydraulic energy.

From available hydro-geologic data projected from the South Louisiana on-shore and offshore regions, geo-pressured wells have been variously estimated to be capable of flow capacities from 1000 gpm to 3000 gpm of hot water at temperatures from 180°F to 330°. In these ranges the hot water available has been projected to be of various salinities, from 20,000 mg/l to 90,000 mg/l. Release pressures from well data indicate 6,000 psi ga at 8,000 ft. of depth to 16,000 psi at 20,000 ft. of depth with favorable geostatic ratios.

In addition, these hot waters have been estimated to contain recoverable methane (CH4) in dissolved quantities from 35 cfm (std. cond.) per barrel to 107 cff/bbl.

A basic assessment of a specific geo-pressured, geo-thermal resource in the form of a singular well indicates opportunities for extraction of energy quotients in the form of:

Thermal	(BTU's)
Mechanical	(pressure, kinetic mass, velocity)
Methane	(CH4)

The most obvious utilizations of these quotients could take the form of:

1.) Multi-stage gas separators to effect the release of dissolved methane (and non-condensibles) from the hot water.

2.) Hydro-turbine(s) to recover mechanical (kinetic) energy from the high pressure, relatively hot water.

3.) Relatively low pressure, heat consuming processes and/or power generating devices for extraction of available btu's from the resource.

Attendant considerations must be given:

1.) To possible subsidence of the areas or locales from which geo-thermal waters had been withdrawn and, also

2.) To the disposal of large volumes of water either to waste or returned to the sub-surface via disposal wells, with due regard for salinity of the waters returned to the sub-surface.

In moderating the data and outlines of various geological appraisals, the assumption of a typical unit, geo-pressured, geo-thermal well having the following characteristics appears to be in order:

Depth	8000 - 15,000 Ft.
Wellhead Pressure	3000/6000 Shut in pressure
GPM Flow	3000 GPM
Temp. °F	240°F
Methane Content	25 cu.ft. bbl.
Salinity (dissolved solids)	20,000 - 90,000 Mg.

This of course dictates that a careful geophysical assessment be made of the hydrogeological characteristics to be expected in any specific area proposed for localization of an industry or group of industries for thermal utilization of the resource when developed.

These relatively quantitative values may be used as inputs to a model to make maximum utilization of the available energy properties and energy levels.

We should review from Fig. 2 the spectrum of media to be captured, harnessed and disciplined upon emergence from the well head.

Even upon the previous characteristic assumptions for a typical unit well, the utilization models may take various forms for projection.

A. In one approach, perhaps optimumly, See Fig. 3.4, the methane (CH4) content in the G.P.G.T. well effluent should be separated from its bearing water at saturation pressures relative to its temperature so that the percentage of hot water flashing to vapor may be minimized. Concurrently the volumes of separated water should be maintained at max. temperature to permit utilization in a broader range of selected thermal equipment.

The methane could either be converted to methanol at the site, and/or consumed in whole or part locally or remotely as fuel.

In considerations of on site consumption, there could be:

1.) Thermal boosting of G.P.G.T. water to those temperatures required by on site processes either as hot water or steam, or by:
2.) Methane firing of conventional boilers for steam power generation.

B. Hydro (Kinetic energy)
Either before or after separation from separation from its methane content, the remaining pressurized water could become the driving medium for a hydro-turbine of the impulse type. The mechanical shaft horsepower developed could become input for pumps, fans, generators, compressors or other on site machinery.

Also dependent upon the salinity of the pressured geo-thermal water there would be significant releases of hydrates as scaling, corrosive and fouling agents within the hydroturbine casing, and associated vessels, valves and piping. This invites careful attention to design materials selection and to operating and maintenance evaluations for any proposed turbine equipment and related appurtenances.

Dependent upon membrane limitations, as to salinity, pressures and temperatures, some fraction of geothermal water could be converted to relatively "fresh" water via osmotic filtration, or converted to distilled water, via single or multiple effect evaporators, for process useage or live-stock watering. The resultant by-product brines could yield recoverable salts whose projected content and volume would be subject to economic evaluation.

Due to membrane sensitivities, the limitations of Osmotic Filtration require: pretreatment of skeline feed waters.

Input: max. salinity 10,000 ppm
Max. temp. 86°F
Min. temp. 32°F
pH range 4.0 to 7.5
Must be free of suspended solids
Iron content (trivalent) must be pre-controlled.
Calcium Carbonate can precipitate as scale or sludge within unit

By assuming a geothermal water temperature of 275°F flash steam could be released for power generation and/or process applications at approximately the saturation pressure of 31 psi ga.

This steam would be available for turbine drives in condensing, non-condensing or binary cycles using secondary working fluids such as propane, isobutane, Freon R-22, R-32 or related organic fluids.

In 'condensing' applications large volumes of cooling water for heat rejection are implied.

In 'non-condensing' applications appropriate utilization of the exhaust steam volumes require attention.

The suggestion of binary cycles in power-generation introduces high installed costs per Kwhr of plant electrical generating capacity and relatively high unit costs per Kwhr produced.

In each of the foregoing, however, a moderation of the limitations of each systems approach is obtainable for good system feasibility.

Returning to the assessment of geo-thermal potentials on a unit-well bases: Unit flow rate of 3000 gpm of geo-pressured, geo-thermal water containing dissolved methane at or near saturation would yield (at 25 std cu. ft. per barrel)

$$\frac{3000 \times 60 \times 24}{42} \times 25 \text{ or}$$

approximately 2.5 million cu. ft. of methane gas per model or unit resource well per day.

When delivered to sales this gas would have an annual market value of $1.3 million per year when priced as low as 1.50 per mcf.

The following list of food products from thermal processes which fall within the energies available from geopressured - geothermal water are indigenous to South Louisiana:
-- cotton seed oil
-- cane sugar
-- alcohl production
-- food processing, growing, cooking, drying
-- fish farming (mari-culture)
-- shrimp, crawfish processing

Possible <u>Geo-Thermal Utilizations</u>:
power generation
refrigeration, air conditioning
food processing and dehydration
process dehumidification LiCl
lumber drying
plywood, veneer, particleboard
paper and pulp
fish farming, aquaculture
space heating

Dehumidification via Lithium Chloride Systems potentials for:
Candymaking
Industrial processes
Hospitals - bacteriological control
Printing
Pharmaceuticals
Powders (edible, ined.)
Films
Plastics
Explosives

The Associated Cooling water requirements for each process must be consistent with:

a.) Ecology and Pollution measures (Environmental Protection)
b.) Legal, Social, Economic Impacts
c.) Water disposal (saline)

Due to relatively broad variations in the G.P.G.T. properties measured from a series of aquifers at depths ranging from 8100 to 20,000+ ft. indicating pressures of 11,000 to 16,000 psi ga, water temperatures 250°F to 425°F, methane content from <u>35</u> cfm per bbl to 107 cfm per bbl, salinity from 12,000mg/l to 90,000mg/l a specific utilization plan should be tailored to the capability of the specific geothermal resource, that is, to the characteristics or properties of the G.P.G.T. well or wells as developed into production.

To coordinate geothermal supply with geothermal demand will require a planned time table of scheduled and completed events culminating in efficient industrial utilization of geothermal energy in plant production processes, fostered by an economic stimulus to the participants.

A sampling of 378 Louisiana industries involved in processing "Food and Kindred" products with evaluations as to annual quantities of energy consumed, with defined peaks, and at specific thermal level requirements has been completed by de Laureal Engineers under ERDA/D.O.E. contract.

This information, in tabulated form, has been assessed for compatibility with energy levels available from geo-resources.

From test data developed by Dr. O. Carroll Karkalits and his team at El Tigre Lagoon, we now have support for values of geopressures, geotemperatures, flow rates and methane content at the well head.

The following listing outlines some of the design considerations involved in proposed commercial utilizations of the geothermal resource:
Salinity
Corrosiveness, PH
Scaling
Hydrate Deposits
Non-Condensible Gases
Toxic Gases (traces) H_2S
Particulate Matter
Water Disposal

It is difficult to have supply and demand occur common in time and place.

This would seem to hold true regarding a source or supply of geothermal energy and the demand for it by industrial consumers.

Obviously then, some provision for transmission of the resource must be made, a pipeline to carry in particular the hot well water from the geo-resource to the plant or operation for utilization. Obviously also, the shorter this pipeline, the less capital will be required to transmit the geo-resource.

So, an approach is that of locating a specific high potential aquifer or reservoir, quantifying and qualifying its characteristics by estimate from well data and then locating candidate industries in close proximity.

In the instance of our food and kindred products study, Dame Fortune has smiled upon SOUTH LOUISIANA in providing one or more very large geothermal reservoirs underlying dozens of candidate industries for utilization of the energy.

Following evaluation of a particular reservoir, an ideal and recommended approach would be that of selecting a fully compatible food industry candidate for site-specific location at the geo-resource.

This operation and all processes within, would be designed to maximize geo-resource utilization within the framework of acceptable marketing and investment considerations.

Some of the prominent candidates include sugar refining, soft drink and seafood preparation, rice milling, vegetable and produce, blanching, cooling, sterilization, canning and packaging operations.

Many of these industries can utilize in some measure geothermal energy when developed and available.

Transmission distance would be minimized to limit capital requirements.

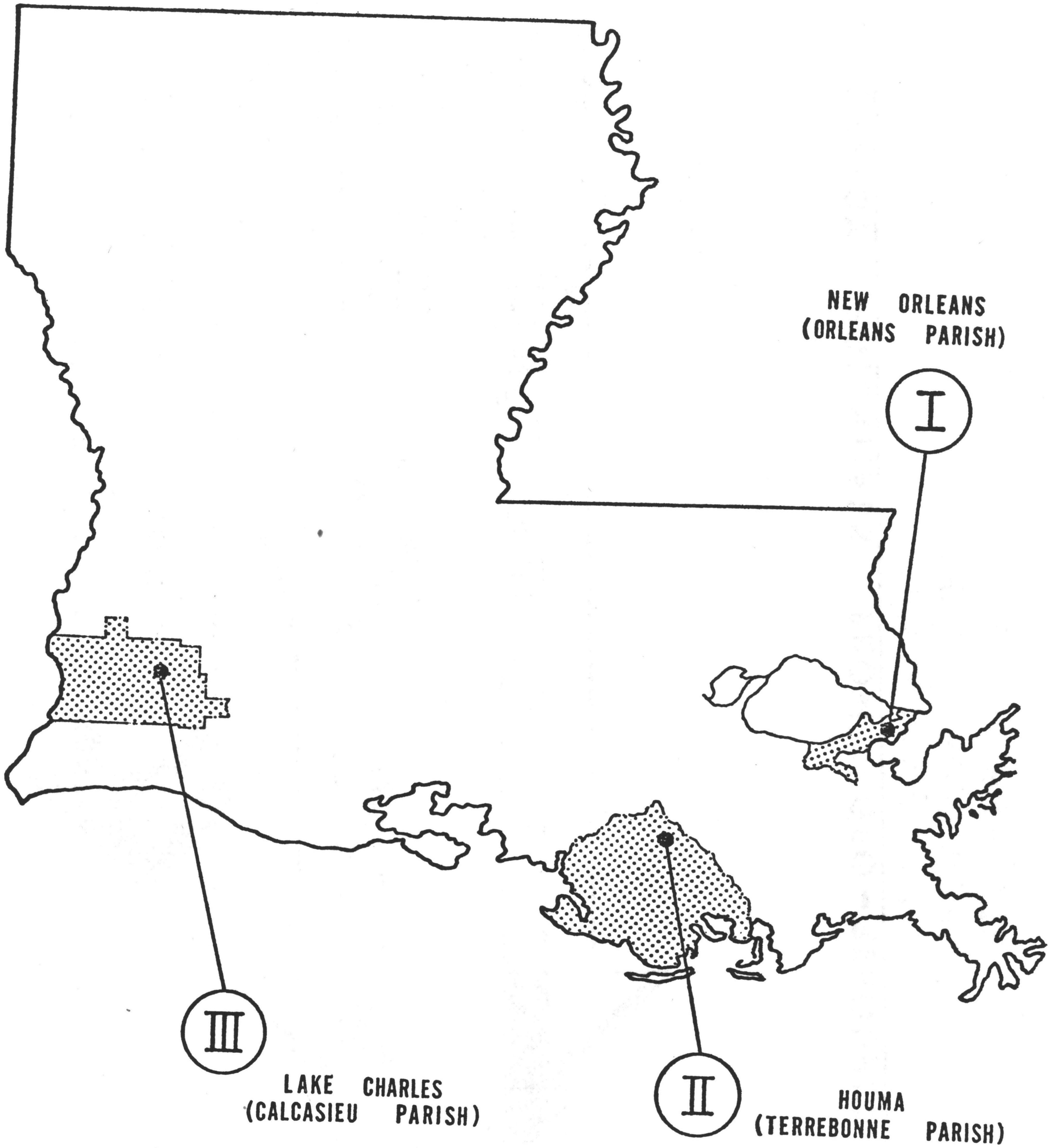
Successive processes, would be arranged in cascading temperature sequence.

Disposal wells discharging into another aquifer at lesser depth would be on site.

The plant would be truly a geothermal energy one, a model for similar operations to follow.

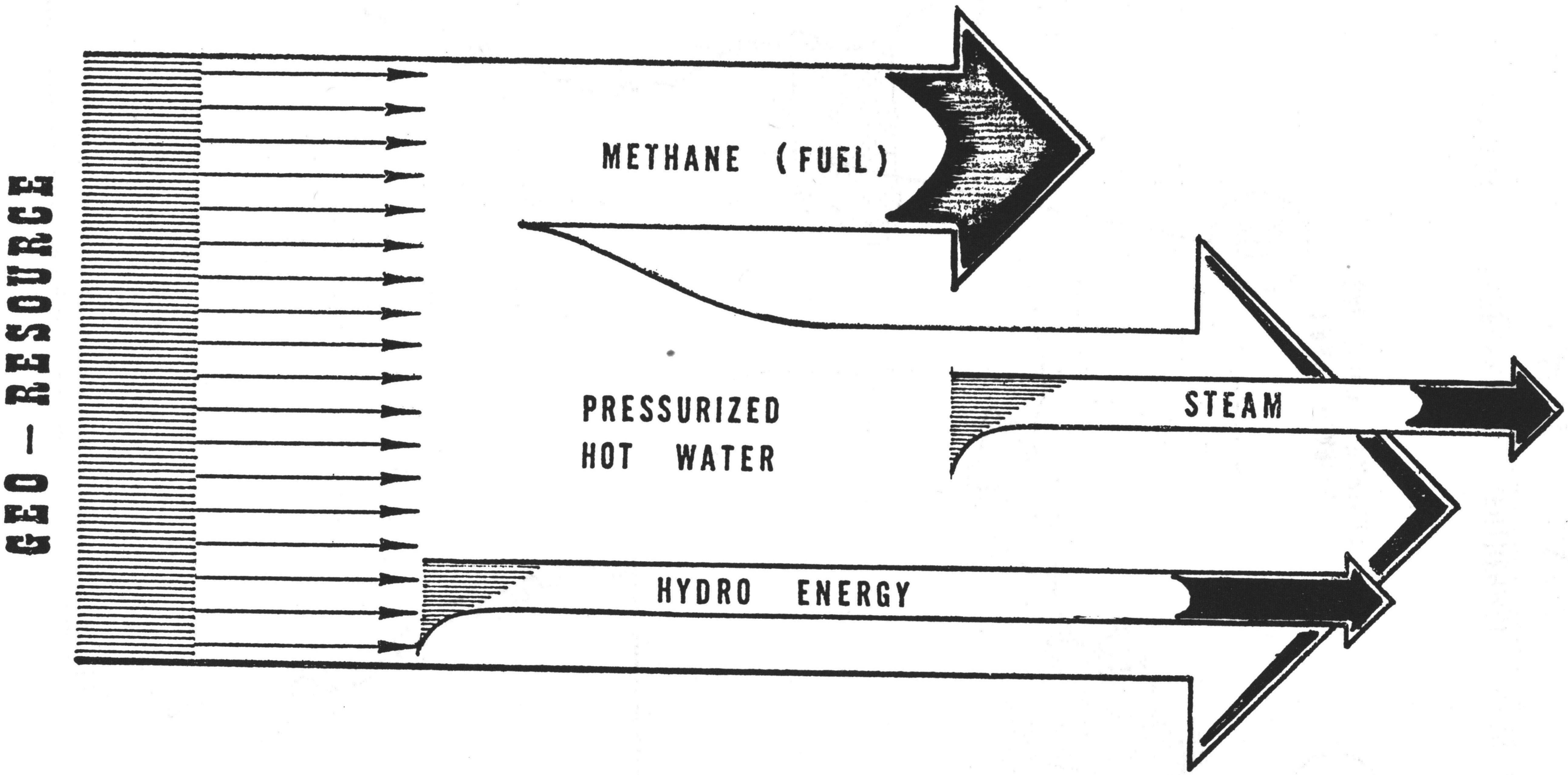
In conclusion,

We believe that we are on the threshold of utilization, under average economic incentives, of a very old energy resource which is within the scope of technologies and associated hardware currently under development.



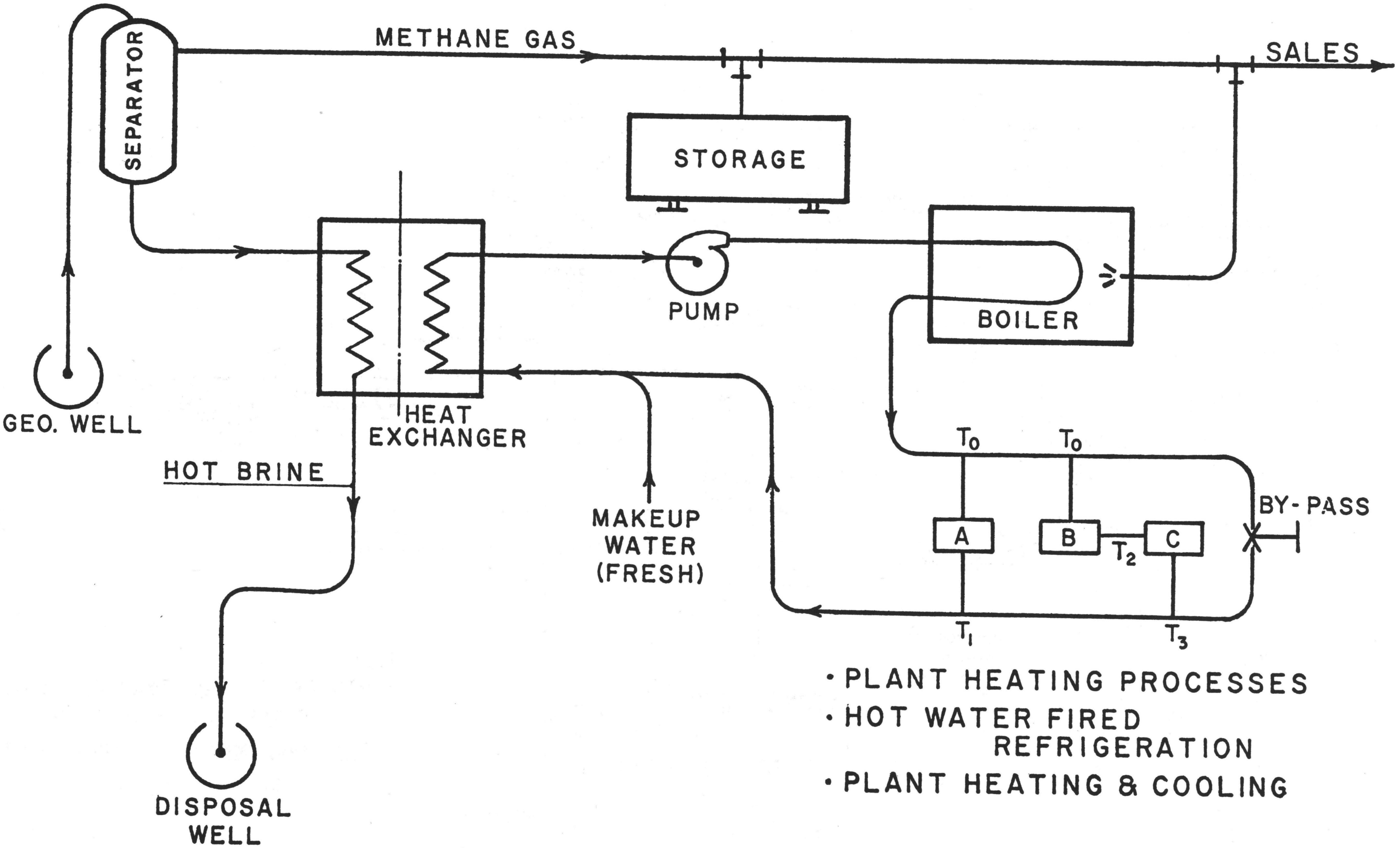
SELECTED GEOPRESSURED GEOTHERMAL AREAS (I, II, III)
SOUTH LOUISIANA

FIG. 1



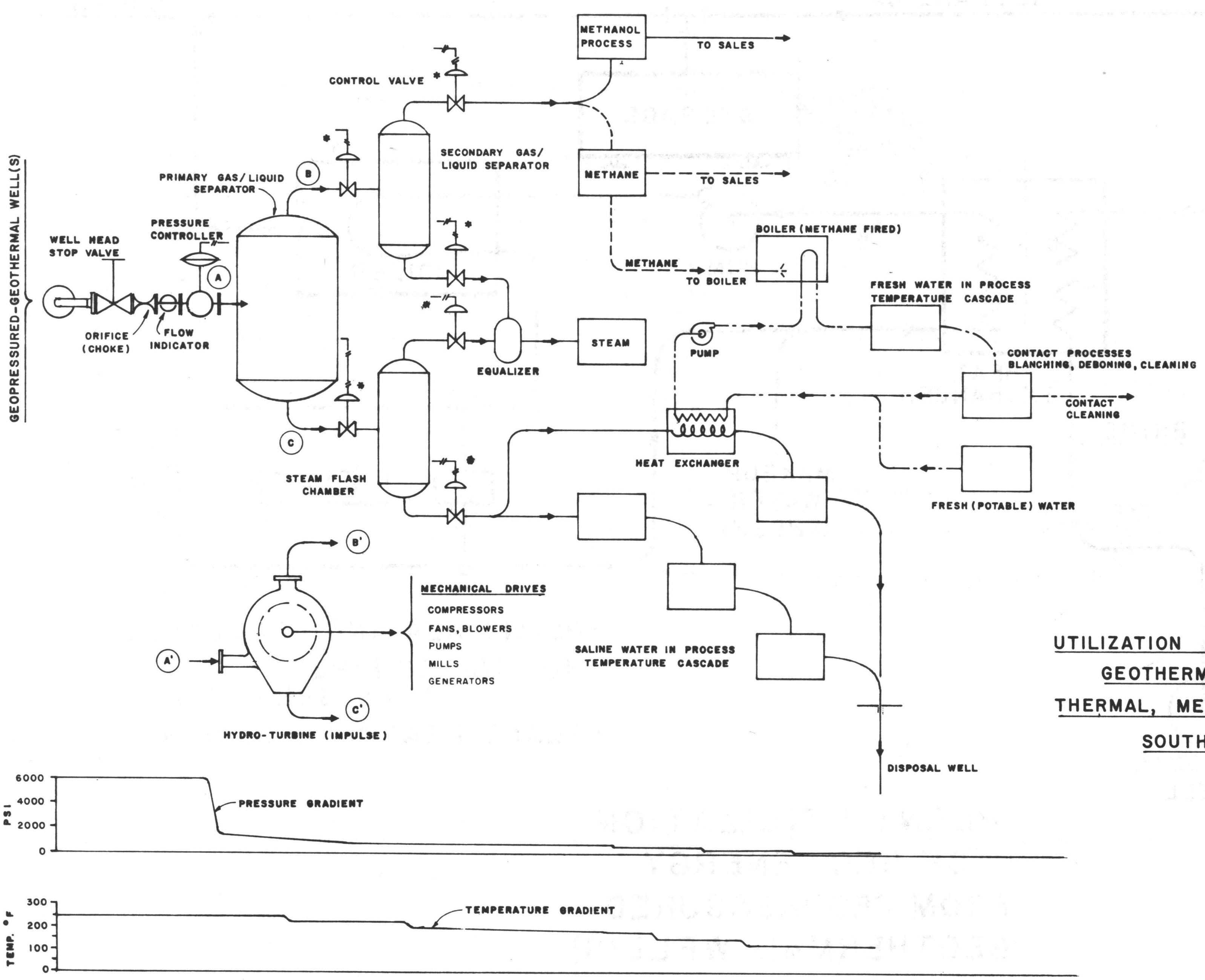
ENERGY POTENTIALS FROM GEO-RESOURCE

FIG. NO. 2



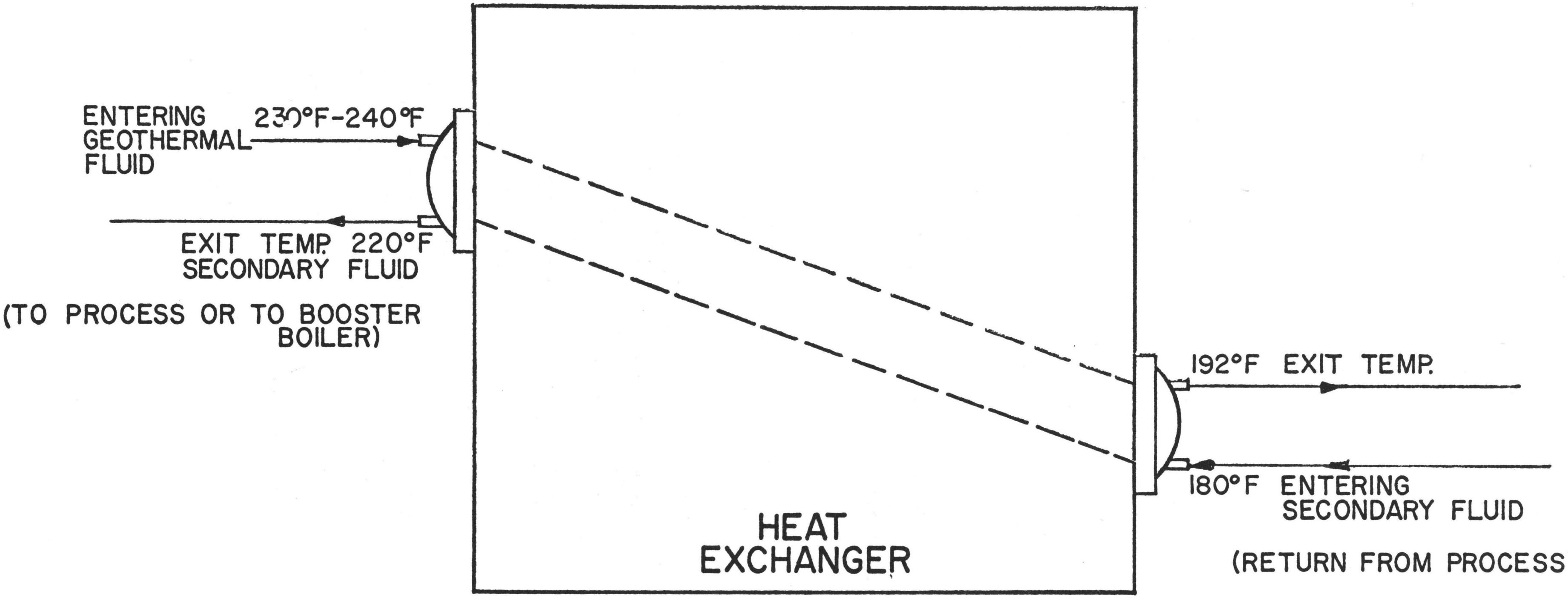
PLANT UTILIZATION
OF GEO-ENERGY
FROM GEOPRESSURED
GEOTHERMAL WELL(S)

FIG. 3



UTILIZATION OF ENERGIES FROM GEOTHERMAL RESOURCES, THERMAL, METHANE, MECHANICAL SOUTH LOUISIANA

FIG. 3.4



APPROXIMATE
TEMPERATURE DIFFERENTIALS
IN PASSAGE OF GEOTHERMAL
FLUID ENERGY TO A
SECONDARY FLUID (WATER)

FIG. 4