Costa Rica *Country* Update **Report**

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Abstrdct

Exploration and drilling activities carried out during the last ten years in the Miravalles geothermal field allowed to extend the proven reservoir area to 20 Km^2. In 1994 the installation of the first 60 MW's in Costa Rica history **was** successfully completed, while another ***55*** MW unit is foreseen to *start* operation in 1997. Feasibility studies far units III an N are in progress, and the instalation of unit III is expected in 1998.

Key Words: Costa Rica, Miravalles, Tenorio, Rincón de la Vieja, scale inhibition.

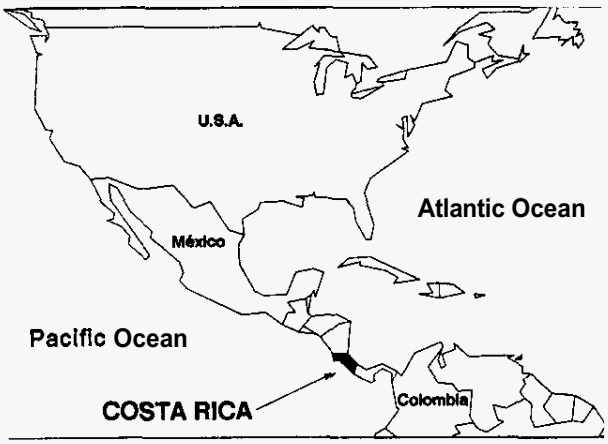

Figure 1. Costa Rica Location

TABLE 1 UTILIZATION OF GEOTHERMAL ENERGY FOR ELECTRICAL GENERATION IN DECEMBER 1994

[1] Data for 1994 if available, otherwise for 1993. Please specify which

Locality		missione	NO of units	*status*	Type of Unit	Unit Rating MW	Total Installed Cap. MW	Annual Energy Prod. [1] GWh/yr	Total under Constr. or Planned MW
Miravalles	liravalles I	**1994**	**1**	Operative	Single flash	55	***55***	409.5	55
Miravailes	loca de ozo I	**1994**	**1**	Operative	Back pressure	5	5	37.2	5
Miravalles	Miravalles II	**1997**	1	Constructior	Single flash	***55***		@ 409.(	55
Miravalles	Miravalles III	**1998**	1	Programed	Single flash	55*		@409.(	
Total	4		4			170	60	1265.7	170

*No yet defined possible 55 MW @ Estimated

Results achieved during **the** period 1990 - 1994

After a period of forced inactivity, geothermal operations started again in 1992 and led to the installation in 1994 of 60 MW, 55 of which are produced by a single flash condensation power plant (unit **I**) while the remainig five MW are generated by a back pressure plant. Another 55 MW **power** plant (unit II) is expected to begin electric production in 1997 (see Table 1).

During this stage particular effort **was** devoted to the drilling of the production and reinjection wells which are needed to operate both unit I and the five back pressure MW plant. To complete the scheduled drilling programme, two rigs were utilized and total of 20 deep **wells** were completed between june 1992 and october 1994 (Tahle *2)*. Ten other deep **wells,** whose caracteristics **are** presented by Mainieri an Vaca (1990) had already been drilled during the 80's. Thirteen of the **20** newly drilled hales **were** programmed **as** production **wells.** While the remainig seven were designed far reinjection **purposes.** Seven of the 13 production wells, together with the previously drilled holes, either are used to get the steam needed for unit **I** and 5MW back pressure plant or **will** be utilized to feet unit **U.** Three production wells cannot be used because of low permeability (well PGM - 09), drilling problems (well PGM - 47) and presence of acid fluids (well PGM - 19). The latter hole, however, has an estimated producction of ten MW and could be used upon acility neutralization. Three other **wells** were drilled to investigate both the northern sector (PGM -14) and the southern **area** (PGM **-28** and PGM -29) of the geothermal field and might be connected to units III and IV.

TABLE 2 WELLS DRILLED FOR ELECTRICAL AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1,1990 **TO DECEMBER** 31, 1994

(Do not include thermal gradient **wells less than** 100 **m** deep)

[1] **Type or purpose of well**

T = Thermal gradient or other scientific purpose
E = Exploration
P = Production
C = Combined electrical and direct use
R = Reinjection

[2] **Total flow rats at given wellhead pressure (WHP)**

Locality	Year Drilled	Well Nvmbcr	Type of Well [1]	Total Depth m	Max Temp. °C	Fluid Enthalpy kJ/kg	Well Output [2]	
							Flow Rate kg/s	WHP bar
Miravalles	93	4	E/P	2184	225	N.A	N.A	N.A
Miravalles	94	8	P	1200	236	1017	233	9
Miravalles	93	9	P	2001	231	N.A	N.A	N.A*
Miravalles	93	14	E/P	1396	237	1027	80	9
Miravalles	92	15	R	3022	246	N.A	N.A	N.A**
Miravalles	92	16	R	1799	225	965	59	8.8
Miravalles	93	17	P	1300	240	1100	135	9.3
Miravalles	93	19	P	1259	233	1002	146	7.5***
Miravalles	93	20	P	1700	232	1019	122	8.8
Miravalles	92–93	21	P	1715	229	990	775	10.5
Miravalles	92	22	R	1427	228	990	165	8.2
Miravalles	92	24	R	1965	228	990	110	7.3
Miravalles	94	25	R	2533	N.A	N.A	N.A	N.A
Miravalies	93	26	R	1578	214	825	69	5.4
Miravalles	94	27	R	1565	223	953	73	9.2
Miravalles	94	28	E/P	1315	228	980	185	9
Miravalles	94	29	E/P	1367	230	990	245	10.7
Miravalles	92–93	31	P	1725	243	1019	91	8.4
Miravalles	92–93	46	P	1196	239	1004	183	9
Miravalles	94	47	P	1955	234	N.A	N.A	N.A*
Miravalles	94	49	P	1309	232	960	103	9

• unproductive
** drilled 1966 deepened 1992
*** pH 3,2
N.A Not available

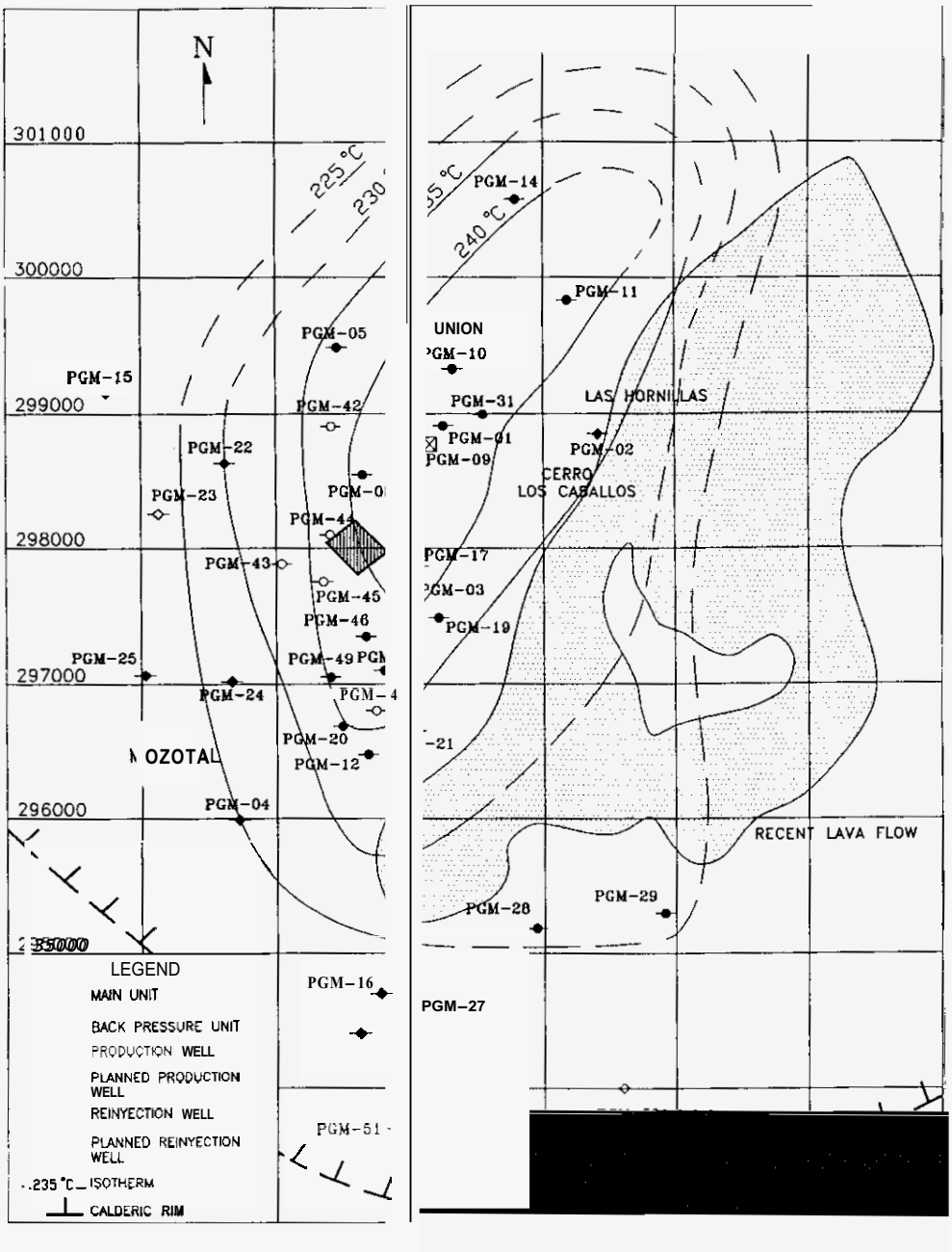

Figure 2. Mirovalles Geothermal Field

For the firts time, **air** was successfully used **as** drilling fluid to complete the **20** holes perforated in **1992 - 1994. Upon** reaching producction **zones,** air **plus** water **was** utilized instead of mud. This procedure allowed a satisfactory recovery of cuttings and did not affect reservoir permeability which is largely controlled by fracturing.

To counteract the tendency of Miravalles geothermal fluids to precipitate calcite, a polyacrylate inhibitor solution is injected into production wells below flashing depth. The injection is made through a 63 mm diameter capillary tubing made of 316 L stainless steel **or** Incoloy **825.** At the surface the tube is connected to **a** storage and pumping system, while at its lower end it is equipped with one injection head whose weight is changed according to the prcduction rate and well diameter. Almost a year of continous operation has shown that the inhibitor is working efficiently and prevents well bore Calcite precipitation

The reinjection system has also given positive results since a significant increase in well injectivity indices has **occurred** upon systematic reinjection of **large volume** of liquids. **The** raise in permeability of reinjection wells is likely to reflect washing out drilling residues and formation of new fractures.

TABLE 3 PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

	Geothemal		Fossil Fuels		Hydro		Nuclear		Total	
	Capac-ity MW.	Gross Prod. GWh/yr	Capac-ity MW.	Gross Prod. GWh/y	Capac-ity MW.	Gross Prod. GWh/yr	Capac-ity MW.	Gross Prod. GWh/y	Capac-ity MW.	Gross Prod. GWh/yr
In operation in January 1995	60	447	156.5	701	793	3773	- - -	- - -	1009.5	4921
Under construction in January 1995	55	409.5	33	144.5	287	1481	- - -	- - -	342	1890.5
Funds committed, but not yet under construction in January 1995	55*	409.5	24	168.2	237.3	1135	- - -	- - -	349.3	1857.6
Total projected use by 2000	170	1266	213.5	1013.7	1317.3	6389.4	- - - -	- - - -	1700.8	8669.1

*** Scheduled on 1998. possible *55* MW.**

After completion of the reinjection holes PGM - *22* an PGM - **24** to the west as well as PGM - *28* and PGM - **29** to the south, however, it was proven that the production area extended in both directions. It **was** also established that the production area is limited hy **the 725°C** isotherm at the **reservoir** tup. To the easl, a recent block lava **flow** limited, until now, exploration activities aimed at testing the possible extensión of the production zone in this direction. ***(See*** figure ***2).***

In order to improve the exploitation of the available geothermal resource stored in the westem and southen sectores of the field, feasibility studies for the istallation of **a** third unit and possibly a fourth one **are** under way at present (Table *3).* Acoording to such **a** programme it is necessary to select suitable reinjection areas. Drilling of three **new** reinjection wells (PGM - 51, PGM - **52,** PGM - 53 in Figure *2)* has, therefore, been scheduled in the southern part of the field nearby the **caldera** rim. Further details are given by Mainieri and Vaca (1990).

Studies performed in Tenorio and Rincon de la Vieja volcanic **areas** during **the 1990 - 1995** period

A prefeasibility study was carried out in the Tenorio volcano area, located about **25** Km to the south east of the Miravalles geothermal fiel (see Figure 3), in the frame of a programme jointly sponsored by the Italian Government and the

Description of the **two** operating plants

The entire geothermoelectric istalled capacity of Costa Rica, i.e.60 MW, refers the two units sited in the Miravalles geothermal field.

The main unit (unit **I)** is a condensation power plant with , **a** gross capacity of *55* MW. It requires 114 Kg/s of steam at 6 bar a for its nominal capacity. Eight production wells connected to four separating units provide the steam for unit I. Six **wells** are used to reinject the separated brines.

The other unit is a five MW back pressure power plant requiring 19 Kg/s of steam at **7** bar a.

The available excess of steam, which is produced by the holes originally designed to feed the main unit, is currently used to operate the five MW plant. The separated brines are disposed through the reinjection system of the main unit.

Future studies and use **of** the field

According to the initial exploitation programme of the Miravalles geothermal field, its central pan was considered to be the production zone, whereas the western and southern sectors were reserved for the reinjection of the separated brines.

United Nations. This study indicates the presence of a geothennal reservoir hosted in volcanic racks, with a temperature of 230 - 240° C, medium to low salinity fluids and ane expected geothermal potential of 100 - 120 MW. Feasibility studies and drilling activity should start in 1996.

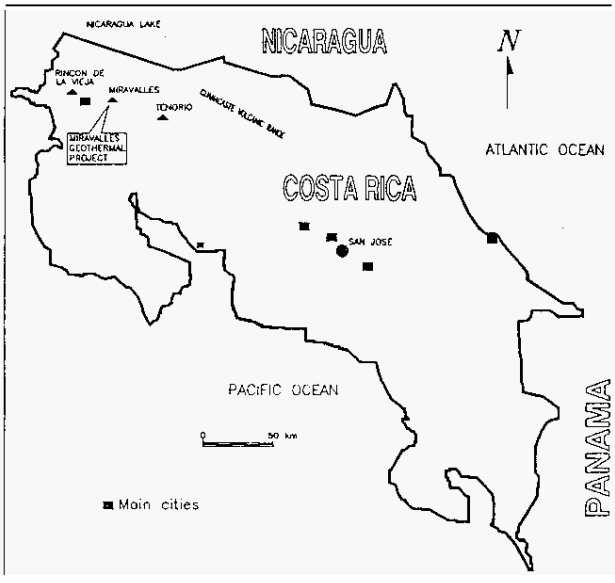

Figure 3 Main Geothermal Sites

Moreover I. C. E. is carrying out prefeasibility studies in the area of Rincon de la Vieja volcano, sited about 17 Km to the north west of the Miravalles geothermal field along the Guanacaste volcanic range (Figure 3). Prefeasibility studies were already carried out in this area in 1975 - 1976. Because of the subsequent inclusion of this prospecting area within the limits of a national park, no further geothennal activity can be canid out there. For this reason and taking into account the high geothermal potential of the area surveyed in 1975 - 1977, ICE decided to extend the geothermal investigation in the zones surronding the national park. As mentioned above these prospections are under way at present and are expected to be completed in 1995. Feasibility studies should begun in 1996. A geothermal capacity of approximately 140 MWe (hypothesizing the use of simgle stage turbines) was estimated for the Rincon de la Vieja area, in the framework of a study caried out to evaluate the national geothennal potential. Further details on this subject are given Cataldi and Mainieri (this issue).

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