SEISMIC EXPLORATION IN THE FUSHIME GEOTHERMAL FIELD, KAGOSHIMA PREFECTURE

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A reflection seismic survey is a very effective tool to define the subsurface structure for petroleum exploration. However, it is often thought that good-quality seismic reflections can't be obtained through geothermal exploration especially in the non-sedimentary field. The following statements explain why its use is not widespread in geothermal exploration.

(1) the difficulty of working in a topographycally rough area
(2) the non-layered and complex geological structure
(3) the low transmission of seismic energy due to volcanic flow covering near the surface

In spite of these difficulties, a reflection seismic survey is expected to be able to detect the indications of faults and fracture zones that may serve as conduits for geothermal fluid.

A reflection seismic survey was conducted at the Fushime geothermal field in 1978, when conventional technic for petroleum exploration was applied. The results didn't provide any significant reflections and useful informations. After examining these data and wells data carefully, we carried out again an experimental reflection survey in order to find suitable field parameters using Yuatsu Impactor* and Vibroseis** at the same field in 1986(Fig. 1). We briefly present here the results of the reflection survey, compared with those of other geophysical investigations obtained in this field.

First of all, the most suitable field parameters were determined after many preliminary tests such as the effects of geophone with 60cm-length spike, downhole geophone setted at 10m depth, frequency of geophone and number of stacks, because (3) described above is a serious problem especially in the Fushime field. The field parameters used in 1978 and 1986 are as follows (Table 1). The new survey is characterized by short geophone interval and short shot point interval as well as a high multiplicity of stacking fold.

	1978	1986	
Energy source	Dynamite 2-3kg/SP	Impactor 10shots/SP	Vibrator 10sweeps/VP
SP(VP) interval	50m	5m	10m
Geophone frequency	8Hz	28Hz	28Hz
Geophone group interval	25m	10m	10m
Number of channels	24ch	96ch	192ch
Sampling rate	2msec	2msec	4msec
Number of folds	6folds	48folds	60folds

Table 1. Specification of reflection seismic survey

As the surface was covered by scoria fall of some 10m thickness with low seismic velocity (400m/sec), strong surface noises were seen in the field records. These noises were effectively reduced by simulating the pattern effect with utilization of short spacing of receivers and shot points.

The processed results show better resolution than the previous data(Fig. 2). Although the reflection horizons are less continuous and consist of many short segments, the structure of shallower zone up to 0.5 sec. is clearly recognized. These have never been found from previous survey and other geophysical surveys. However, the data was limited and not sufficient to determine the deeper structures, such as welded tuff and dacite encountered by drilling, and further research is necessary. Nevertheless, the results of this recent survey were much better than those of the previous survey. In the Fushime geothermal field, a reflection seismic survey may be proven to be a very useful tool to delineate geothermal structure in the future.

* an accelerated weight drop system developed by Japex Geoscience Institute inc.

** trade mark of CONOCO Inc.

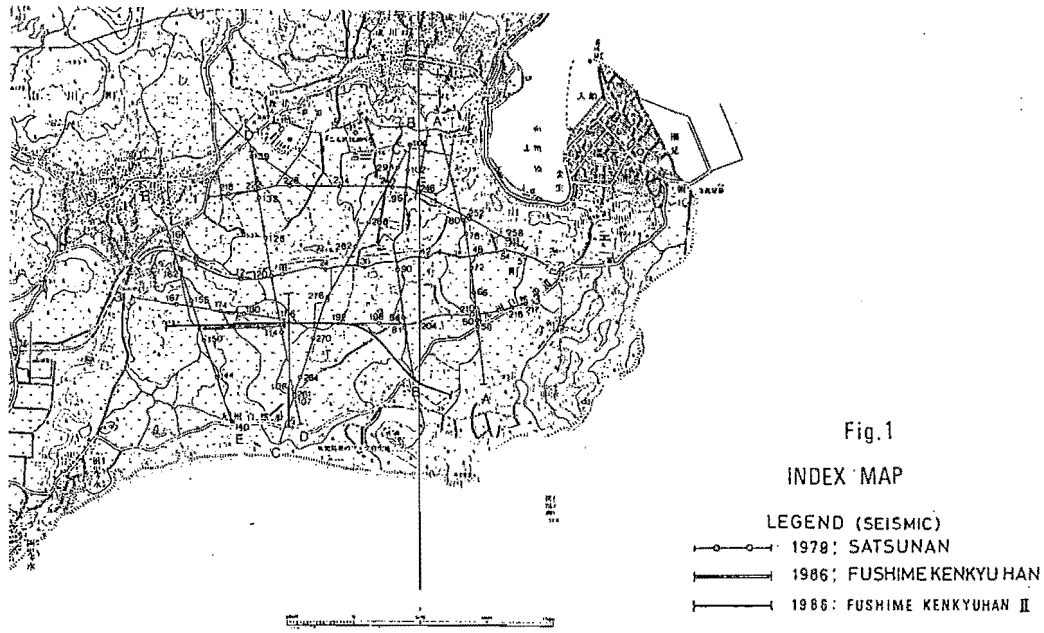

Fig. 1 Map showing the location of survey lines

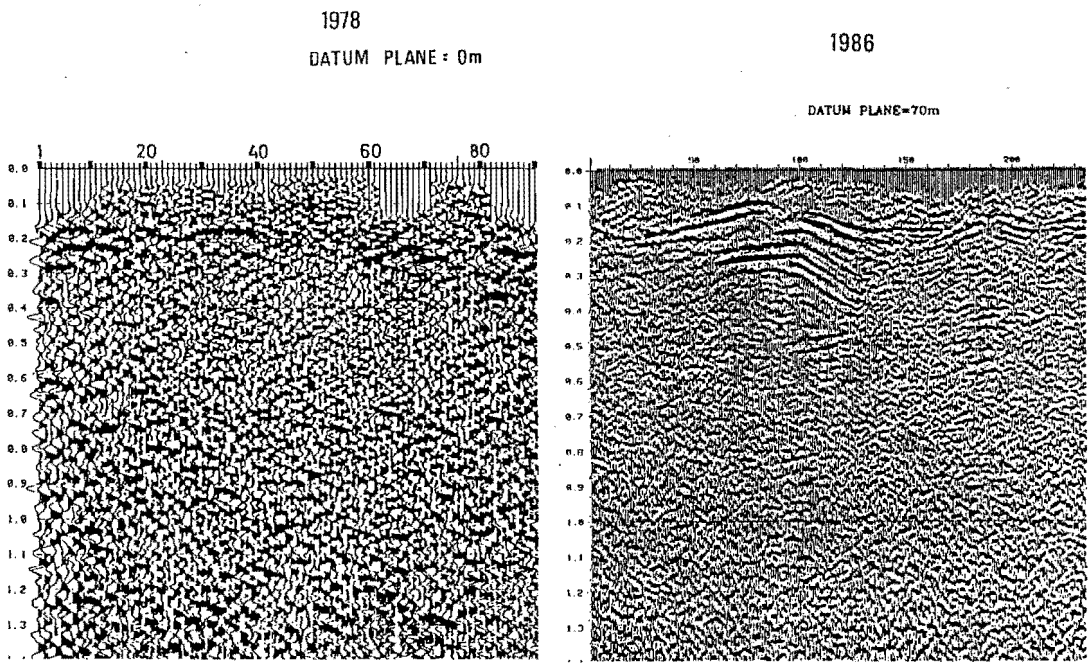

Fig. 2 Comparison between seismic section in 1978 and seismic section in 1986