# SEISMIC SURVEY OF DECEPTION ISLAND.

# DECEMBER 1999 – MARCH 2000.

**DECVOL and ANT98-1111 PROJECTS.**

## INTRODUCTION.

The present seismic survey has been ideated in two phases. The first one consists in the deployment of the seismic network and in a rapid evaluation of the level of the seismic activity in order to establish the activity level before the opening of the Spanish Antarctic Base "Gabriel de Castilla". This is part of the objectives of the multidisciplinary DECVOL program. In the second phase a continuous monitoring of the seismicity during the summer will be performed as for scientific purposes as to establish different alarm levels for the people living and visiting the Island. This second phase corresponds to the ANT98-1111 Project.

## 1 – FIRST PHASE:

The first phase consists in setting up a short period digital seismic network along the coast of Deception bay (Port Foster) and a Broad Band station. The main purpose is to rapidly locate and quantify the energy of the volcano-tectonic, LP and tremor events occurring in the first week, with the aim of checking if the seismic crisis occurred during January-February 1999 is still in action.

Several types of instruments are utilized:

Type a). #6 3-D short period seismic stations, equipped by MARK L4C-3D sensors, 16 bits dynamical range and local recording onto P.C. HD, sampled at 200 sps (see fig 1 and 2).

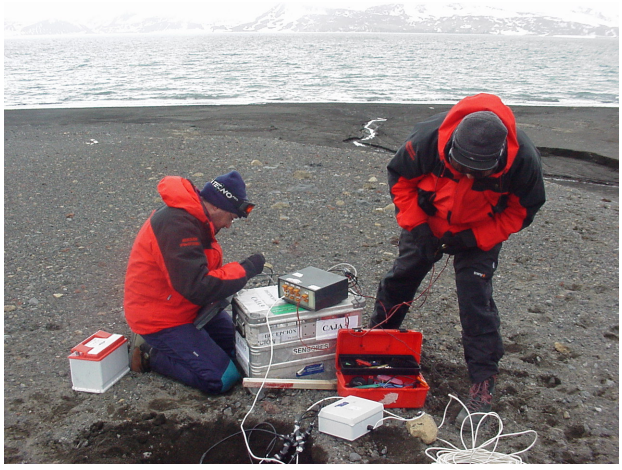


Figure 1.

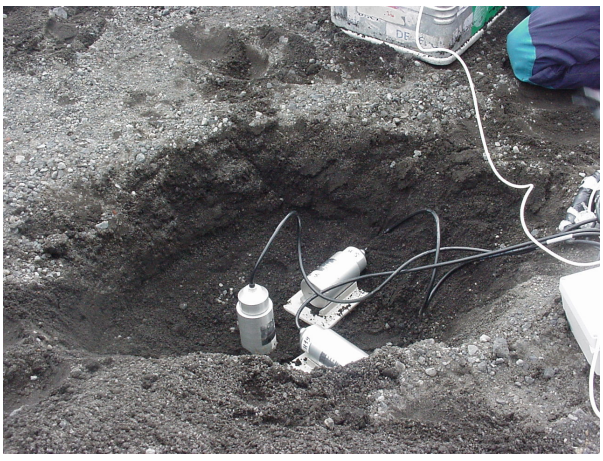


Figure 2.

Type b) #1 digital telemetry 1-D seismic stations, 24 bits dynamical range, MARK L4-C equipped. (50sps) powered by solar panels and a 2 Watts power radio (figures 3 and 4).

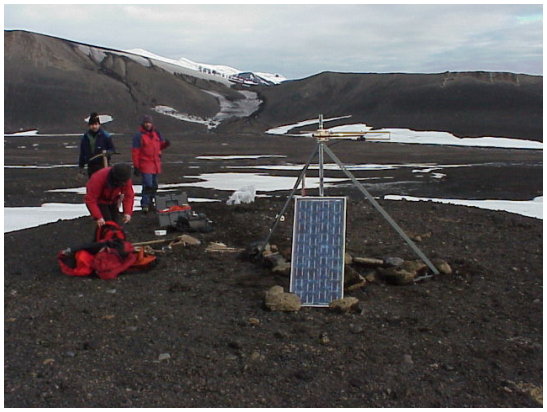


Figure 3

Figure 4

Type c). #1 3-D 24 bits dynamical range station, cable connected to the base (local recording), sampled at 50 sps and equipped by Mark L4C sensors (figures 5 and 6).

Figure 5

Figure 6

Type d). #1 Broad Band Guralp CMG40T (60 s natural period) with digital local recording onto P.C. HD with a 24 bits A/D converter system and sampled at 100 sps. (figures 7 and 8).

Figura 7

Figura 8

In figure 9 a map of Deception Island is shown together with the position of the seismic stations deployed in the present experiment.

**1.1 Set up schedule** (see enclosed map).

1st day: Installation of stations DFUS,DFUN,DBID (type a).
Initial part of the installation of DBAS (type b), DBAB(type d), DCRA (type c).

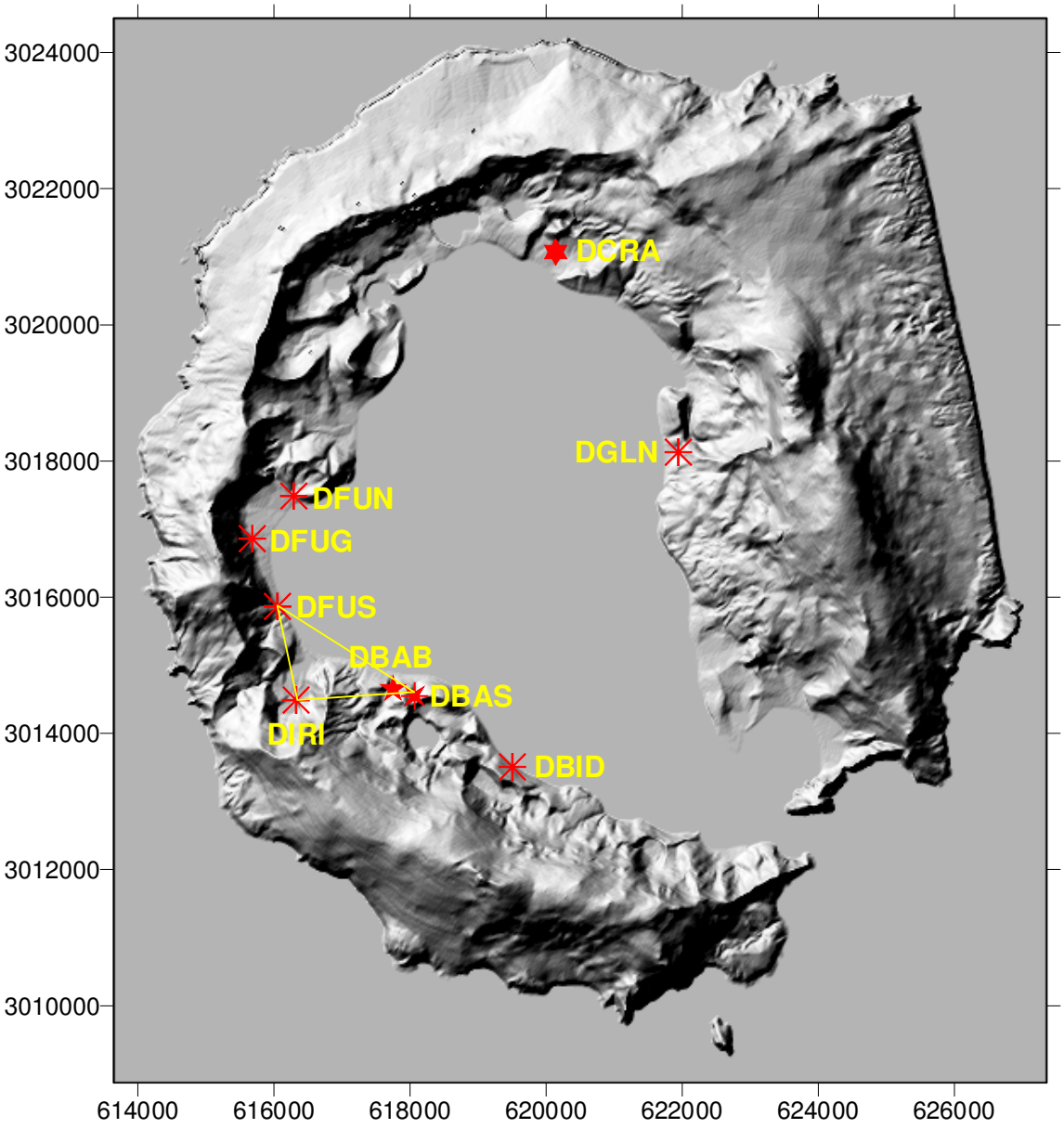
2nd day: Installation of station DFUG and DIRI (type a).
Installation of DCRA , DBAB and DBAS.

5th day: Installation of station DGLN (type a).

The GPS team of the University of Cadiz, which attends to GPS measurements in the DECVOL experiment positioned the seismic station points using differential GPS technique. The co-ordinates of the seismic stations are:

DFUG 62º 57'41.023'' S; 60º42'59.353'' W
DFUN 62º 57'16.676'' S; 60º42'33.982'' W
DGLN 62º 56'40.849'' S; 60º35'59.621'' W
DBID 62º 58'08.146'' S; 60º42'36.064'' W
DCRA 62º 55'07.575'' S; 60º37'53.968'' W
DBAB 62º 58'40.105'' S; 60º40'33.662'' W
DIRI 62º 58'51.571'' S; 60º42'16.074'' W
DFUS 62º 58'08.145'' S; 60º42'36.064'' W

# MAP OF DECEPTION ISLAND.
# SEISMIC STATIONS OF THE 1999-2000 SEISMIC EXPERIMENT.




✳ 16 BITS - LOCAL RECORDING (3D).

★ 24 BITS - DIGITAL TELEMETRY VIA RADIO (1D).

✳ 24 BITS - DIGITAL TELEMETRY VIA CABLE (3D)

★ 24 BITS - BROAD BAND STATION (3D).

Figure 9

### 1.2 Data recording.

Type-a stations record files 150 s long continuously (30 seconds apart each other).
Type-b, c and d have continuous recording systems.

### 1.3 Instruments maintenance schedule.

***All the days:***

Power battery change and data storage for type a stations.

Data storage for stations of type b, c and d.

Check of radio telemetry.

***Problems.***

Sensitivity of horizontal components to ground tilt, due to the unstable permafrost basement. This problem is solved by a continuous check of horizontal component leveling.

Damages due to strong wind (up to 30 m/s) for station DIRI, DFUS and DFUN. Solved changing cables and using some spare parts.

### 1.4 Data pre-analysis.

A visual inspection of the seismic records from the station which was left in function at the Gabriel de Castilla base since the end of the last experiment (1998-1999 Antarctic Summer) was carried out. A decay of the seismic energy with time was observed till to the beginning of April 1999. In April 6, 1999 the data recording was stopped due to insufficient power supply.

Stations DBAS and DCRA are continuously monitored onto P.C. screen. This allows for a fast control and classification of the volcanic quakes.

Data from the rest of the stations, after the storage onto a HD of the PC analysis, are tested and classified using EXAMEN and PICFASE. These programs are available at MNCN-Madrid and University of Granada (IAG).

Locations are performed using software LOCAntar (Geiger method) and TRIPA (apparent slowness and back-azimuth from a tripartite array). LOCAntar is used when earthquakes are recorded at more than 4 stations (this software is in use in the IAG). TRIPA is used when earthquakes are recorded by the tripartite array located close to the base (see yellow triangle of fig.9).

### 1.5 Seismicity.

The seismicity recorded during the first phase results to be mainly composed by low energy volcanic tremor and low-frequency events. These tremor and low-frequency events are well recorded at DBID and DIRI stations. One VT was recorded at station DFUG at 2a.m. GMT time at a distance of about 1.5 km far from the station. One strong LP was recorded simultaneously by all the stations in the afternoon of December 4. The LP event arrived first at DBAS station, and was not localized due to the absence of a clear first P onset. The present level of activity is around the same level of that recorded during the 1994-1997 experiments and clearly lower than that observed during the 1998-1999 experiment. For a complete description of the characteristics of this seismic activity see Ibáñez et al. (1999).

### 1.6. Definition of the volcanic alarm levels.

Ortiz et al. (1998), Almendros et al. (1997), Alguacil et al. (1999) and Ibáñez et al. (1999) reported that Deception Island has suffered different eruptive periods in the last 30 years and several seismo-volcanic swarms. For the safety of the research groups working in the Antarctic bases of this island and of the numerous tourist groups that arrive into Port Foster in summer we established a protocol in order to define a rough division into four alarm levels which is presented In the following tables.

## 2. SECOND PHASE:

The rapid evaluation of the seismicity level of Deception Island has allowed us to define the level 1 or Green. In this case the seismic station of type a) were set up in trigger mode (on the base of the STA/LTA ratio). The second phase started in December 7$^{th}$ and will end at the end of February or possibly at the middle of April. At the end of the second phase, the seismic network will be dismounted except for the broad band station, which will remain in function for the whole year. The sampling rate of the broad band station will be changed to 40 sps in order to allow for an optimal data storage. A second broad band seismic station is in operation in Livingston Island since December 7$^{th}$. This last broad band station will be also in operation for the whole year.

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(all photos by Roberto Quass and Raquel Boza)

| COLORS FOR ALERT LEVELS AT DECEPTION ISLAND | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **COLOR** | **SWARM ACTIVITY (EVENTS PER HOUR)** | | | | **DAILY AVERAGE** | | | **Temperature and gases** | **Visual observation** | **ACTIONS** |
| | **VT** | **LP** | **TREMOR** | | **VT** | **LP** | **TREMOR** | | | |
| **G R E E N LEVEL 1** | No | No | No | | N < 30 of magnitude < 2.0 | < 30 | No or low amplitude | No changes | No evidences | Comunication. Systems in trigger mode. |
| **ORANGE 1 LEVEL 2** | 0 < N < 10 | 0 < N < 20 | Low amplitude | | 30< N<100 or some of 2.0<M<3.5 | 30<N<100 | The amplitude grow or change in frequency | No changes | No evidences | Comunication. Night sourvillance every 4 hours. Systems in continuous mode |
| ORANGE 2 LEVEL 3 | 10< N < 25 | 20< N <40 | Significative | | 100<N<200 or some of 3.5<M<4.2 | 100<N<300 | Still grow in amplitude | Small variations | No evidences | Comunication. Night sourvillance every 2 hours. Alternative security base. |
| **R E D LEVEL 4** | N > 25 | N > 40 | Felt Tremor | | N > 200 or some of M>4.2 | N > 300 | Felt tremor | Significative variation | Yes, as new fomaroles, visible fractures, or deformation, etc. | Comunication. Possible evacuation. Desplacement to the alternative base. |

**EVERY ELEMENT HAS TO BE CONSIDERED INDEPENDENT OF THE OTHERS.**
**THE FIELD OPERATOR DOES NOT INTERPRETED THE DATA, THE INTERPRETATION IS DONE BY A SCIENTIFIC COMMISION.**
**THE COLOR CHANGE FORCES TO FOLLOW THE PROTOCOL.**
**FROM LEVEL 1 TO LEVEL 2 ONLY ONE CONDITION HAS TO BE FULFILLED.**
**FROM LEVEL 2 TO LEVEL 3 AT LEAST TWO CONDITIONS HAVE TO BE FULFILLED.**
**FROM LEVEL 3 TO LEVEL 4 THREE OR MORE CONDITIONS HAVE TO BE FULFILLED.**
**TO DECREASE THE LEVEL THE SAME CONDITIONS OF THE CORRESPONDING INCREASING LEVEL HAVE TO BE CONSIDERED**