GEOSCOPE : state of the art 2004

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I - INTRODUCTION

The GEOSCOPE program was launched in 1982 by the National Institute of Sciences of Universe (INSU), a department of the French National Center of Scientific Research (CNRS), at the instigation of the Institute of Physics of the Earth of Paris (IPGP). The purpose was the installation of about 25 stations well distributed worldwide (in particular in the southern hemisphere), in the standard configuration defined by the FDSN (very broad-band 24 bit, continuous recording at 20sps).

II – The NEW GEOSCOPE CHALLENGE

In 2002 we've decided to replace the old Streckeisen digitizers with new Quanterra type ones, in order to be ready for the next step which will consist in gathering data towards our Data Center in real-time. The challenge is to link the maximum number of stations to Data Center for real time and continuous transmission of data in few years.

We are able to upgrade 3 or 4 stations every year, giving priority to the ones easy to link permanently to Paris. For the last ten years we've been progressively installing microbarometers and thermometers, transforming all our stations in multiparameter observatories.

III - STATIONS

The GEOSCOPE program is operating 26 *digital 3-component very- broadband* stations. The location of all present and future GEOSCOPE stations is presented on the joint figure. Data from large events are teletransmitted from some stations (by phone RTC line or through internet) and made available within one day. A satellite transmission system is now working, in cooperation with the french military agency CEA/DASE, in cooperation with CTBTO (Dzumac in New Caledonia), and the data are available continuously, with a low gain. The next CTBTO/GEOSCOPE stations to be teletransmitted according to that process is ATD (Djibouti) in early 2005.

In terms of siting locations, the aim of the GEOSCOPE program is almost fulfilled; we plan to install a new station in **MARQ** (Marquesas Islands) in cooperation with CEA/DASE, one in **Russia** at high latitude at **VOR** (Vorkouta), and one in Patagonia (**COY** in Chile). In the framework of cooperation between IRIS and GEOSCOPE we installed in March 2004 a joint station at **TRIS** (Tristan Da Cunha). Our purpose is to fill some geographical gaps in the southern hemisphere. DCC in Antarctica will be a joint EOST/Concordia station.

IV – GEOSCOPE and the real-time: in 2004 SIX STATIONS IN QUASI REAL-TIME

The installation of new 24bit dataloggers (Q4128, Q330-6, DASE datalogger) allowed us to receive data in quasi-real time from the following stations:

1- DZM Dzumac in New Caledonia
2- FDF Fort de France in West Indies
3- SSB St Sauveur-Badole in France
4- RER Rivière de l'Est , La Réunion
5- KIP Kipapa, Hawaï, a joint GEOSCOPE/IRIS station
6- TRIS Tristan Da Cunha, a joint GEOSCOPE/IRIS station

The data are now visible in real-time in the Data Center in Paris ; they will be available to everybody in a very near future, as soon as the transfer functions have been verified.

V- DATA AVAILABILITY

The GEOSCOPE Data Center has been completely reorganized around a RAID disks system in 2000. All incoming data are stored after data quality control. The Media on which the data are stored depend on the date; there are three main different media, CD-Rom for data spanning time from 1982 to 1992, a disk for recent teletransmitted data, and RAID disks for all data from 1982 up to now. Different ways for getting the GEOSCOPE data are available :

A) GEOSCOPE AutoDRM : the NETDC procedure (Networked Data Centers)

This is actually *the only way for getting the data*. The necessity for dissemination of large datasets to the seismic community lead to a new form of distribution with cooperative environment between the different data centers. The NETDC idea makes the access to data transparent to users, who should not bother about where to ask for data. The routing of the data request should be solved by the coordinating data centers.
Some Data Centers are currently networked (IRIS, GEOSCOPE, NCEDC (UC Berkeley) and ORFEUS) with the NETDC device. You can retrieve the INVentory, the instrumental RESPonses and the DATA directly on your disk.

B) Anonymous ftp for recent events

Remote accessibility is possible for Data Center in 15 teletransmitted stations by telephone line or through Internet link. You can get data for all recent events with magnitude Ms > 6.0 or with particular scientific interest (location, focal depth) within 1-2 days.

C) CDROM production (for data from 1982 to 1992)

All data from March 1982 (82.061) to July 1992 (92.189) are written on CD-Roms in old SEED format and the whole collection (37 CD-Roms) has been distributed worldwide without charge to about 200 users. Because the easier way of doing provided with Internet, the CD-Rom production is interrupted.

VI - OTHER PRODUCTS

A- THE GEOSCOPE STATION BOOK

The updated version of the station-book is available on the web site. It references the technical details for each station (http://geoscope.ipgp.jussieu.fr). The history of each station is described with information about the parent organization, the network affiliation, the vault conditions, the site description, the instrumentation, the sensors, the primary and auxiliary channels as microbarometers and thermometers, the dates of upgrade, the sensitivities in the flat part of the band-pass of the instrumental responses. The corresponding plots can be easily downloaded.

B -GEOSCOPE CMT DETERMINATION

An inversion method for the fundamental mode Rayleigh wave spectra has made possible the rapid determination of the mechanism and the seismic moments. It's been proven that a correct CMT can be retrieved by using few stations, and that in a laterally heterogeneous Earth. This determination is done routinely for all events with Ms > 6.8 from the teletransmitted stations data.

C- THE SEISMIC NOISE LEVEL PLOTS of all GEOSCOPE stations

The estimate Power Spectral Density plots have been computed for the year 1995 and are available on the Web site, for the 3 channels VH, LH and BH, and the 3 components. We are determining the same plots for the year 2003.

D - DETERMINATION OF 'OVERLOOKED' EVENTS IN THE SOUTHERN HEMISPHERE

Some small to medium earthquakes are not detected and thus are not referenced in the earthquake catalogues. Most of these events are in the southern hemisphere where the lack of seismic stations creates a detection sensitivity gap. We estimate that more than a hundred southern hemisphere events per year with magnitude between 4.5 and 5.5 go undetected by the worldwide networks. We use a surface wave analysis method to effectively detect and locate these earthquakes, particularly near-ridge events.

VII – PRESENT NEW DEVELOPMENTS

A - GEOSCOPE AND THE DEVELOPMENT OF MULTIPARAMETERS STATIONS

We plan to equip all stations with seismometers but also with microthermometers, microbarometers, inclinometers, short period seismometers, in order to clean the seismic signal and to study potential correlations between the seismic signal and these environmental parameters. Some of our stations have long seismic time series (going back as far as 1982). SSB (Saint Sauveur Badole) in France and TAM (Tamanrasset) in Algeria also have long-term pressure measurements (as far as 1988). Removing the atmospheric pressure effect is absolutely necessary for scientists using low frequency free oscillation modes.
We are planning a cooperation with the GGP network (Global Geodynamics Project), we hope to compare both a vertical STS1 seismometer and a SG superconducting gravimeter, first in J9 site (near Strasbourg) and secundly in PPT (Papeete). The SG data will be distributed by the french GEOSCOPE Data Center in Paris.

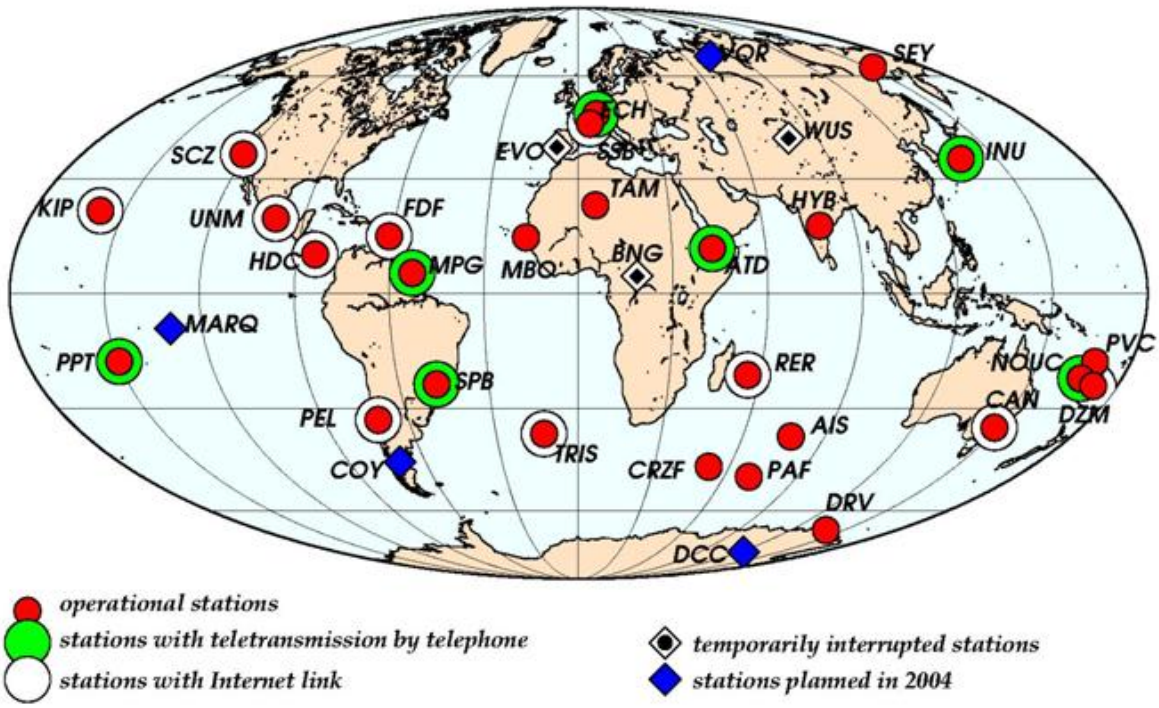
B – GEOSCOPE and the STS1 seismometers

Most GEOSCOPE stations are equipped with STS1 seismometers, only a few ones with STS2 seismometers. Because we plan to move some stations from the northern hemisphere to the southern one, in order to fill a geographical instrumental gap, we are fixing or upgrading a lot of STS1 seismometers. We plan to install 3 STS1 in COY (Patagonia) in cooperation with the University of Chile.

C -- GEOSCOPE AND THE CTBTO

In the framework of the CTBTO/IMS (Comprehensive Test Ban Treaty Organization/International Monitoring System), at least three GEOSCOPE stations have been chosen as auxiliary stations, DZU (Dzumac) close to NOUC in New Caledonia, ATD in Djibouti, MBO in Senegal. Dzumac in New Caledonia is providing data in real time (low gain continuous data). We are interested by doing the same in French Guiana (MPG) and Russia (SEY). These 5 sites are all CTBTO auxiliary stations (ASxx).

GEOSCOPE stations as of July 2004



Recent installations and/or future sites

March 2004

TRIS Tristan Da Cunha since March 2004
joint CTBTO/GSN/G station

June 2004

RER upgrade with a Q330 digitizer and continous transmission

FDF continuous transmision to Paris

September 2004

SSB upgrade with a Q4128 digitizer

WUS upgrade with a Q4128 digitizer

November 2004

MARQ Marquesas (G/DASE)

COY Coyhaique in Patagonia (Chile)

In 2005

TAM, SPB upgrade with Quanterra digitizers

VOR installation of Vorkuta, Russia

DATA DISTRIBUTION

1) Anonymous ftp site (ftp://geoscope.ipgp.jussieu.fr)

Events with Ms>6.3 or of particular interest are uploaded from 17 stations by phone line. The data are available within one or two days.

2) WWW server (http://geoscope.ipgp.jussieu.fr)

Products :Station book — Instrument responses
Noise level plots — Plots and data files of recent events
Real-time data from SSB station (in France)
Archived data files

3) NetDC (Networked Data Centers) procedure at netdc@ipgp.jussieu.fr

The best way to get information from all Networked Data Centers, IRIS, NCEDC, GEOSCOPE, ORFEUS, GNDC, MNDC

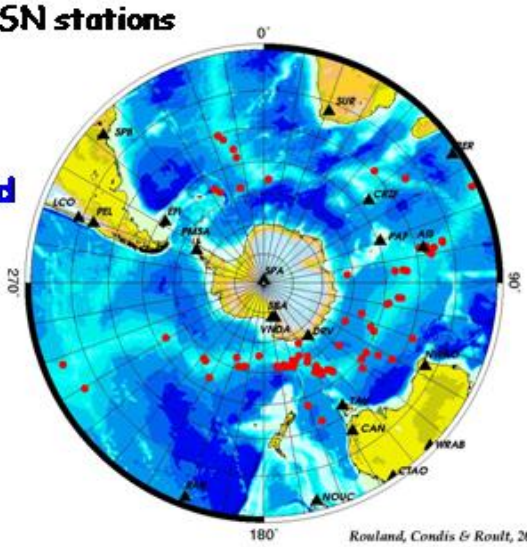
You can retrieve: the INVentory
the instrumental RESPonses
the DATA directly to your disk

GEOSCOPE provides a unique station distribution that permits:

1. a better azimuthal coverage
   → seismic source studies

2. ray paths not provided by other FDSN stations
   → tomographic studies

3. detection and location of events **that would otherwise be overlooked** in bulletins of global seismicity, thanks to our southern hemisphere stations (exemple in year 1999, Rouland et al., 2003)



Rouland, Condis & Roult, 2001

▲ Broad-band stations used in this st

● Epicenters determined in this study

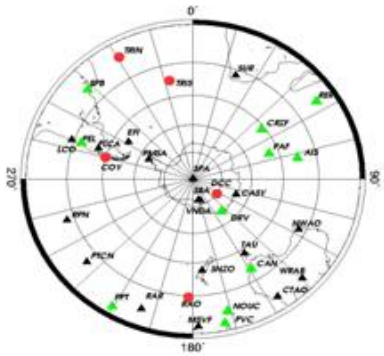
What's new ?

1) We are transferring the maintenance of some stations from IPGP to local authorities.

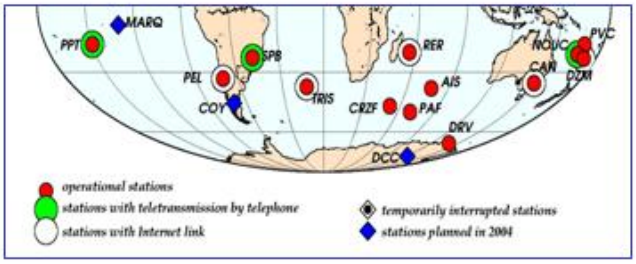
KIP (Kipapa) is now a joint IRIS/GEOSCOPE station
SCZ (Santa Cruz) could be maintained by Berkeley University

2) We are (re)installing new original sites in the southern hemisphere

TRIS	Tristan da Cunha in Atlantic Ocean (CTBTO/IRIS/GEOSCOPE)
COY	Coyhaique in Patagonia (Chile)
MARQ	Marquesas islands (GEOSCOPE/CEA/DAQSE)
DCC	Antarctica (joint italian CONCORDIA station)



▲ FDSN operational stations
▲ Geoscope operational stations
● planned stations



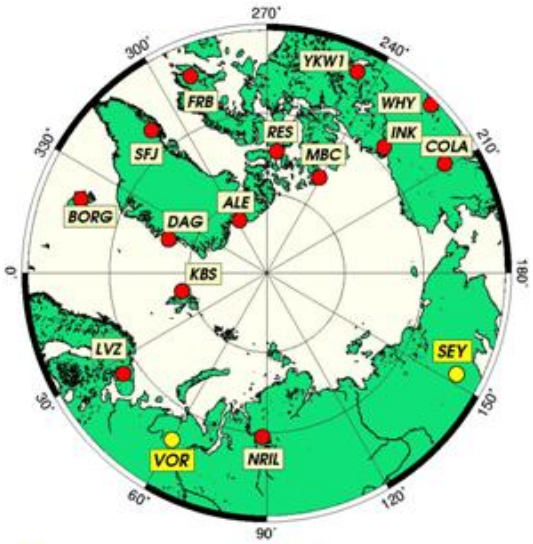
What's new?

2) We are (re)installing new original sites at high latitudes in the northern hemisphere

VOR	Vorkuta in Russia
SEY	Seymchan in Russia

Why?
These future stations are on the same meridians than seismic regions.
The PKP waves provided by such polar paths will help our knowledge on anisotropy.

Stations at latitudes > 60deg Nord



○ Geoscope ● Iris_DMC

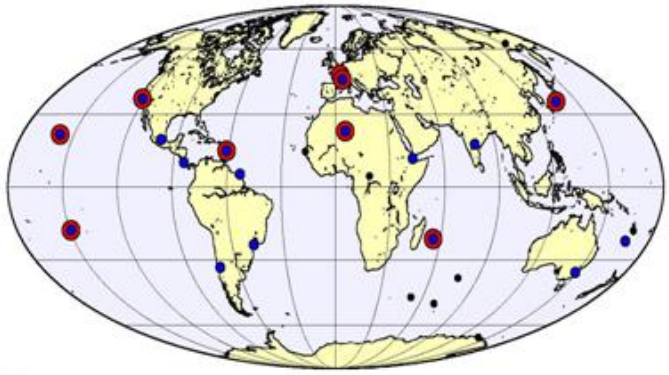
What's new?

3) We are standardizing the acquisition chain (digitizers)

We'll keep our STS1 seismometers as long as possible
We started to replace our old Streckeisen digitizers by Quanterra ones

4) We are installing microbarometers and thermometers in all stations.

Why? To improve the signal to noise ratio by subtracting the atmospheric pressure effect. Some Geoscope stations are now equipped with microbarometers and thermometers.



microbarometers
thermometers
all stations

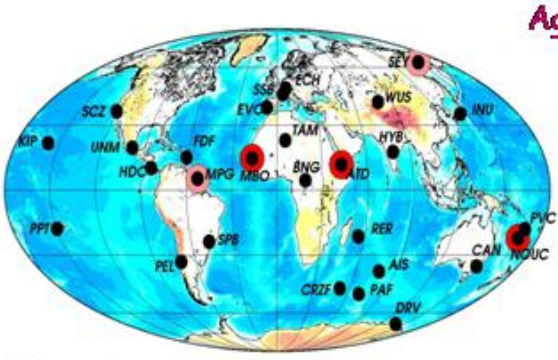
What's new?

5) We are cooperating with CTBTO or DASE at some stations

Five stations are involved by CTBTO.

- AS32 Dzumac in New Caledonia is operating since March 2003.
- AS28 ATD (Djibouti) is planned at the end of 2004.
- AS97 MBO (Senegal) is planned in 2005.

Agreement between Geoscope and CTBTO



Geoscope stations
Geoscope / CTBTO stations

Dzumac, in New Caledonia, a quasi real-time station

. Continuous data at 20sps in quasi real-time

. Low gain in order to get unclipped records in case of large near events

What's new?

6) We are adopting the best adapted solution for every station to get real-time data.

Seven stations are already connected through an Internet link. For some others, we are planning installation of Internet:
by satellite at:
- SSB station (Saint Sauveur, France)
- COY station (Coyhaique, Patagonia, Chile)
by ADSL at:
- RER station (La Reunion Island)

RER, La Reunion Island

From vault to world data will travel through: optical fiber + ethernet bridge + ADSL

What's new?
GEOSCOPE and the ocean bottom conquest

7) We wish to obtain a better path coverage of the Earth by cooperating with all ocean bottom projects. At present, different concepts are being analysed in Japan, in Europ (France,...)

We'll cooperate with any operational project in order to install a few stations on the ocean bottom floor, to provide a better instrumental coverage of the Earth.

NERO Observatory (Ninety East Ridge Observatory), a joint IPGP/JAMSTEC/IFREMER project planned in 2005.

In summary: Milestones for future

1) Transfer the maintenance of some stations ...
2) Install new sites at high latitudes (North and South)
3) Standardize the acquisition chain (Quanterra digitizers)
4) Install microbarometers and thermometers in all stations
5) Cooperate with DASE and/or CTBTO to get real-time data.
6) Adopt the best adapted real-time solution at every station
7) Obtain a better path coverage of the Earth by installing the NERO observatory