GEODIS (GEOphysical DIving Saucer): A portable ocean bottom broadband seismic station

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1/ Scientific goals

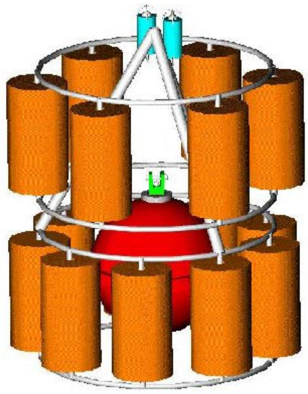
The last ten years have seen the simultaneous developmentf a global seismic network coordinated through the FDSN (Romanowicz and Dziewonski, 1986) and of portable broadband seismic arrays. The same approach can be followed for improving our scientific understanding of the Earth processes below oceanic areas. These two components of ocean bottom geophysical networks, might be coordinated by ION (International Ocean Network; Suyehiro et al., 1995). They are complementary they enable to investigate the Earth structure and active processes at different spatial and temporal scales. Permanent Ocean Bottom Observatories and temporary portable seismic stations are sharing common technological problems. However, issues of power-supply and of real-time transmission are more crucial for an observatory than for a temporary station. Following the recommendation of ION (Montagner and Lancelot, 1995) concerning the operation on the bottom of the sea of Geophysical instruments and particularly VBB Seismometers, the Geoscope/OFM/VBB group of the IPGP has developed a prototype of an autonomous VBB seismological station named GEODIS. This station might be one basic and central element of a permanent observatory. It relies on the use of adapted VBB sensors issued from space experiments and technology and on improved electronics compared with previous ocean bottom experiments (Montagner et al., 1994a,b; Stakes et al., 1998; Romanowicz et al., 1998; Stutzmann et al., 2001)

2/ Major characteristics of the station

2.1/ GEODIS: GEOphysical DIving Saucer

•Qualified for 6000 meters depth
•Size 930x930x430 mm (37x37x17 inch)
•Weight in air is 135 kg (298 lb) and 90kg (200 lb) in water
•3 axes Very Broad Band sensors (120 sec- 0.2 sec)
•1 infrasonic pressure wave sensor (sensitivity 1E-2 Pa)
•1 scientific temperature (sensitivity 1.E-3 °K)
•Energy Li batteries 75 KWh
•Data acquisition on RAM disk 2Go

2.2/ GEOMAS : GEODIS Module of Assistance and Services

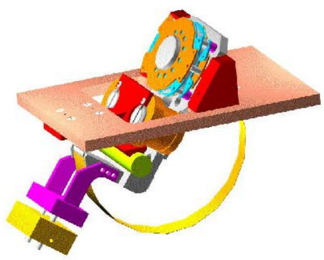


To install the GEODIS without the assistance of ROV (Remote Operated Vehicle) or Submarine and to demonstrate the ability of the system to operate at the bottom of the sea, we have designed and assembled a module called GEOMAS.

The system is basically a sphere (heritage of previous experiments such as SISMOBS 1992) associated with a structure made of Al tube supporting 2 acoustic releases and transponders to take care of releasing the dead weight and of the extra buoyancy . The third one is redundant of the most important one. It will be used as a telemetry system to send few words and to give status of the installation process and successful run of the acquisition system (flash card and mass memory).

3/ Instruments on board GEODIS :

3.1/ Very broadband seismometer .



- Inverted pendulum with a moving mass of 125 grams.
- Resonant frequency : 1.28 Hz.
- Quality factor of the sensor : around 150 inside vacuum.
- Displacement sensor :differential capacitive transducer with high gain 1V/µ and very low noise (better than 1 nm at 0.01 Hz).
- Feedback force (around 30N/A) produced by a set of 4 coils each of them with 250 turns of Copper wire (17 ohms) inside housing in soft iron used as a shield and concentrator of flux for 2 sets of 2 SmCo5 magnets mounted in opposition with an optimized gap in between.
- Centering by moving (Portescap motor) a small mass of 14 grams with a resolution around 1 µm.
- Mechanical locking of the pendulum by an extended coarse of the equilibrium device.
- Pivot 16 blades of CuBe2 alloy (similar to the one designed for the VBB Martian sensor provided by company SODERN-EADS).
- Moving and fixed parts of the pendulum made of Ti alloy.

3.1.1/ Leveling platform

The triaxial VBB sensors are mounted on a platform mechanically linked to a set of a 2 axes motors . They are actuated by a device which generates pulses of 2msec width and of variable number and polarity. For that purpose, the microprocessor, devoted to manage GEODIS, receives the output of a digital electronic inclinometer (provided by APM instrumentation) with each axis well aligned (better than 0.1 degrees) on the same axis as the motor. A soft locking device ensures a very good stability of the leveling system which consequently makes the leveling automatic.

3.1.2/ Sphere under vacuum.

The Archimedes effect of the air affects the seismometer performances. A vacuum must be done in the sphere in order to ensure a good performance of the whole system.

3.2/ Infrasonic wave sensor

An infrasonic sensor was built at the laboratory by using a differential pressure gauge provided by EFFA-DRUCK with a sensitivity of 1.E-2 Pa and a dynamic range of 2000 Pa ; the detector is immersed inside oil shell Morlina 10.

3.3/ Temperature sensors

A small temperature sensor has been developed at the laboratory: Platinum sensor PT 100 (4 ohms / degrees K; 1000 ohms at zero °C) Sensitivity in the range better than 1milli Kelvin.
The sensor is inside a small tube made of steel in order to be qualified for 6000 meters depth.

4/ Energy

The energy is given by Lithium batteries stored inside either the GEOMAS sphere : around 75 KWH devoted to power the main electronics units or inside 3 of the cylinders inside GEODIS to power permanently the real time clock (SEASCAN) and the sensors.

The following table gives the power consumption for each module:

Module Désignation	Alim.	Origin of Power	mA- W	Available power
		Cont Bat/Temp		
Temperature :	10.5v	**container Temp/Bat**	**5mA- 50mW**	**2x3=6 batteries Li**
Pressure Sensor :	10.5v			**i.e. 36Ah=185days**
Seismos module:	+/-7v	**container Temp/Bat**	**2x50mW**	**(2x3)x2=12batt. Li**
				i.e. 2x36Ah=185 days
		Geomas Sphere		
Ageco module:	+/-5v_+5v	**Geomas**	**100mA- 0.5W**	
(USO)	+7.0v	**autonomous**	0.6mA- 5mW	*12Ah/7v Li =833jrs*
Acquisition module: SEASSMO	+5v	**Geomas**	**200mA- 1W**	
Data logger:CADO	+5V/12V	**Geomas**	**600mA-3W**	
Total Power Consumption:			average=3W **margin=0.5W** **peak=7.5W**	
AUTONOMY:: **100 days**	**24v**	**Geomas** **(52Ah/0.13)x6**	**0.13A -3.2W**	**6 pack Li -24V** **(52Ah/24v)x6**

5/ Electronics

The central sphere in Titanium alloy contains VBB sensors and proximity electronics ; the digitizer (4 channels with 24 bits at 20 SPS for the 3 VBB sensors and the infrasonic signal, and 16 channels with 16 bits at 1 SPS for housekeeping channels such as 3 POS, 3 temperatures, 2 inclinometers, and others HK) in association with the real time clock from Seascan. They are all located in cylinders.
The temperature sensor and Li batteries to power all the GEODIS sensors are located in another cylinder .
The micro-controller and the data logger are located inside the third cylinder. The two other cylinders are filled with Li batteries.
a block diagram of the full electronics is given on the figure on the next page.

6/ Schedule

A campaign of validation of the installer and recovery system is programmed for June 01in the Mediterranean sea and a first campaign of operational measurements is scheduled in September 01 certainly in the Thyrenean sea at the place where GEOSTAR2 was installed during the campaign (Sept00 to April 01).

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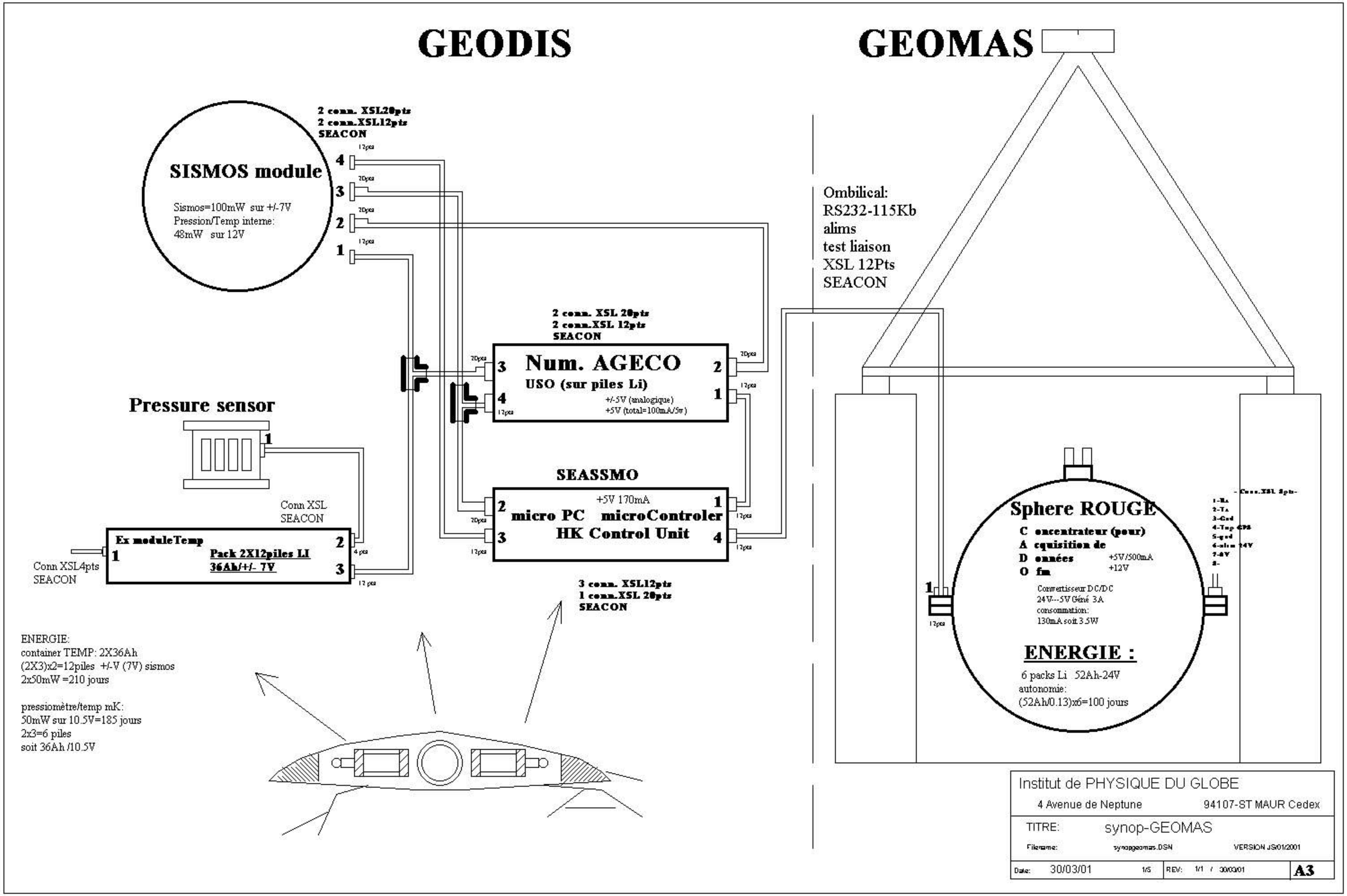

GEODIS
GEOMAS
SISMOS module
Sismos=100mW sur +/-7V
Pression/Temp interne:
48mW sur 12V
2 conn. XSL20pts
2 conn.XSL12pts
SEACON
Ombilical:
RS232-115Kb
alims
test liaison
XSL 12Pts
SEACON
2 conn. XSL 20pts
2 conn.XSL 12pts
SEACON
Num. AGECO
USO (sur piles Li)
+/-5V (analogique)
+5V (total=100mA/5v)
Pressure sensor
SEASSMO
+5V 170mA
micro PC microControler
HK Control Unit
Conn XSL
SEACON
Ex moduleTemp
Pack 2X12piles LI
36Ah/+/- 7V
Conn XSL4pts
SEACON
3 conn. XSL12pts
1 conn.XSL 20pts
SEACON
Sphere ROUGE
C oncentrateur (pour)
A cquisition de
D onnées
O fm
+5V/500mA
+12V
Convertisseur DC/DC
24V---5V Géné 3A
consommation:
130mA soit 3.5W
ENERGIE :
6 packs Li 52Ah-24V
autonomie:
(52Ah/0.13)x6=100 jours
ENERGIE:
container TEMP: 2X36Ah
(2X3)x2=12piles +/-V (7V) sismos
2x50mW =210 jours
pressiomètre/temp mK:
50mW sur 10.5V=185 jours
2x3=6 piles
soit 36Ah /10.5V
Institut de PHYSIQUE DU GLOBE
4 Avenue de Neptune
94107-ST MAUR Cedex
TITRE:
synop-GEOMAS
Filename:
synopgeomas.DSN
VERSION JS/01/2001
Date:
30/03/01
1/5
REV:
1/1 / 30/03/01
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