AN APPLICATION TO INTEGRATE BATHYMETRIC AND OTHER DATASET TO STUDY GAS HYDRATES RESERVOIR.

Accettella Daniela [(1)], Giustiniani Michela [(1)], Tinivella, Umberta [(1)], Accaino Flavio[(1)], Loreto Maria Filomena[(1)]

(1) Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS, ITALY,
Email: daccettella@ogs.trieste.it,
mgiustiniani@ogs.trieste.it
utinivella@ogs.trieste.it
faccaino@ogs.trieste.it
mfloreto@ogs.trieste.it

ABSTRACT

In this work we show an application of geographical information system for integrating bathymetric and other dataset to study gas hydrates reservoir along the South Shetland Margin (Antarctic Peninsula). The main goal of this project was to map the regional distribution of gas hydrates reservoir. In this area, an integrated approach has pointed out the presence of gas hydrates reservoir. The available geophysical information are the following: Multibeam data, seismic images, 2D and 3D velocity and porosity models, 2D and 3D gas phase concentrations, pore pressure information, chirp images, gravity core analysis and CTD data. This integrated approach has allowed us to obtained regional information, such as geothermal gradient, by correlating all available data and obtaining 3D information distribution.

1. GEOPHYSICAL DATASET IN THE STUDY AREA

This study shows an application of Geographic information System (GIS) in order to store available data acquired offshore South Shetland Margin and in particular Multibeam data essential for the characterization of the sea bottom. The dataset was acquired in the frame of two projects regarding the integrated data analysis for the gas hydrate reservoir characterization supported by the National Program of Antarctic Researcher (PNRA). One of the main goal of these projects is to obtain a reliable model of this area in order to understand the origin of the hydrates, to predict possible future scenarios related to the climate change and environmental effects and to investigate the relationship between tectonic and gas hydrates formation.

In this context, GIS is a very useful tool to develop a database where all information can be stored, managed and integrated.

The study area is located in the South Shetland continental margin, as shown in Figure 1, where the gas hydrates reservoir was detected from analysis of seismic data because of the presence of the Bottom Simulating Reflectors (BSRs; i.e. Tinivella and Accaino, 2000). This reflector is generated by the strong contrast of acoustic impedances between sediments filled with gas hydrates and sediments filled with free gas trapped below the hydrate stability zone.

The Multibeam data, covering an area of about 4500 km^2, has given an important contribution to recognise important features such as mud volcanoes and slides, which can be related to the gas hydrates presence. Anyway, a strong BSR was identified on several multichannel seismic reflection profiles acquired during three cruises on the Austral summer 1989/1990, 1996/1997 and 2003/2004 (Tinivella and Accaino 2000; Tinivella et al. 2007). During the cruises, more than 1000 km of multichannel and single channel seismic reflection data were acquired using the following streamers: 1) 3000 m long 120-channel analogue streamer (during the first two cruises) and 2) 600 m long 48-channel analogue streamer (in the last cruise). In the last two cruises, Ocean Bottom Seismographs (OBSs) were also deployed.

Beyond the seismic data, the following data were acquired:1) 4 measurements of water velocity profiles by using CTD, two of them in correspondence to sample cores. 2) 2 sample gravity cores performed in proximity of the possible mud volcanoes detected by integrated analysis of chirp, seismic and Multibeam data; 3) Gravimetric data; 4) CHIRP data.

2. DEVELOPMENT OF GIS PROJECT

GIS project has been developed using ArcGis 9.1 software. The first step of this study consisted in finding available geographic information and geophysical data from bibliography or downloading them from websites. We report the principal source for our scope:

1. Bathymetry of the Antartica obtained from General Bathymetric Chart of the Oceans (GEBCO);
2. Geographic lineaments, such as line coast, downloaded from Antarctic Digital Database (ADD). This information can be downloaded from the website of Scientific Committee on Antarctic Research – SCAR 2008 (http://www.scar.org). ADD is a database containing topographic and

geophysical data. All the data has been furnished from many scientific communities involved in Antarctic research.

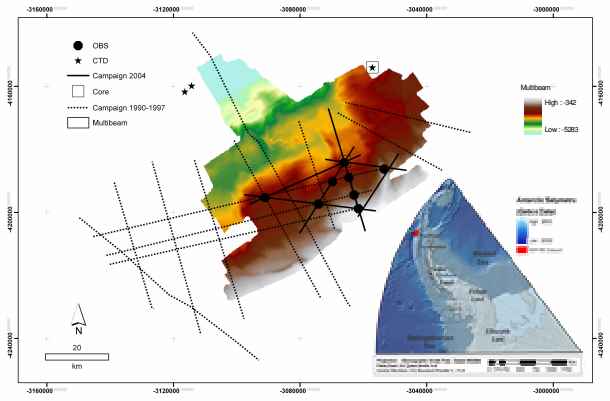

Figure 1. Map showing the locations of the study area, airgun seismic lines acquired in 2004 (continuous lines, present study), 1990 and 1997 (dotted lines, cf. Tinivella and Accaino 2000). CTD measurements (stars), the two coring sites (square), and the border of the Multibeam survey are reported (modified after Tinivella et al. 2007). The Mercator projection with standard parallel equal to 61°S and spheroid WGS84 was adopted.

All information including data acquired in the two projects described in this paper will be projected by using Polar Stereographic Projection with standard parallel equal to 71°S and spheroid WGS84, which is the projection adopted by the SCAR. In this way, at the end of the project, we could share our database with all institution involved in Antarctic research.

The GIS was very useful in the integration of available dataset. First of all, we have compared the Multibeam data with the BSR depth obtained from seismic data in order to understand if the presence of gas hydrate are related to some anomalies, such as geothermal gradient anomalies. So, the integration of different data has permitted to extrapolate regional information.

In the future, the 3D seismic velocity field will be imported in the GIS project and compared with the multibeam data in order to identify the zones with gas hydrates.

3. APPLICATION OF GIS: SOME EXAMPLES

In this section, we show some examples of the GIS application to characterise the gas hydrate reservoir. A grid, showing the difference between the BSR depth obtained from the seismic data and the sea bottom depth (*Figure2*), was created. The red circle shows an anomaly related to the presence of mud volcanoes.

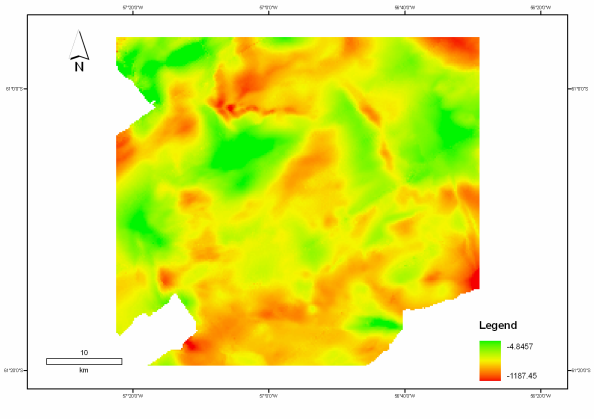

Figure2: Correlation between multibeam (sea bottom depth) and seismic data (depth of the BSR from pre-stack migrated data) in order to detect anomalies related to anomalous geothermal gradient

Theoretical depth of the BSR was calculated by using Sloan equations (Sloan, 1998) and adopting the following mixture of gas deduced from core analysis: 90% Methane, 5% Ethane and 5% Propane. The following geothermal gradient values were tested: 30 °C/km, 32.5 °C/km, 35 °C/km, 37.5 °C/km and 40 °C/km. In the Figure below, the grids obtained by subtracting the BSR depth obtained from seismic data and BSR depth obtained from theoretical models using different geothermal gradient values are shown. Assuming the error of the BSR depth calculated from seismic data equal to about 5%, we have considered just values, whose difference is less than 5% of BSR depth obtained from seismic data in each point. The analysis of these grids suggested that the regional geothermal gradient could be in a range of 37.5 and 40 °C/km.

4. REFERENCES

1. Sloan E.D. Jr. and Koh C. A., 1998: Clathrates of Natural Gases. *Marcel Dekker, Inc. (New York), CRC Press, International S. Book Nr. 13: 978-0-84 93-9078-4*, pp.705;
2. Tinivella U., Accaino F. and Della Vedova B., 2007: New geophysical data to map the active fluid outflow in gas hydrate reservoir offshore Antarctic Peninsula. *GeoMarine Letters*, DOI 10.1007/s00367-007-0093-z;
3. Tinivella U., Loreto M.F. and Accaino F., 2008: Regional versus detailed velocity analysis to quantify hydrate and free gas in marine sediments: the South Shetland margin case study. *Geol. Soc. of London*, In press.
4. Tinivella, U., Accaino, F. and Della Vedova, B. [2007] New geophysical data to map the active fluid outflow in gas hydrate reservoir offsore Antarctic Peninsula. *GeoMarine Letters,* DOI 10.1007/s00367-007-0093-z (2007)
5. Tinivella, U. and Accaino, F. [2000] Compressional velocity structure and Poisson's ratio in marine sediments with gas hydrate and free gas by inversion of reflected and refracted seismic data (South Shetland Islands, Antarctica). *Marine Geology* **164**, 13-27 (2000)