CORRELATION BETWEEN BSRS DIFFERENT ORIGINS AND ANTARCTIC SEDIMENTARY DOMAINS

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Introduction. The recent discovery of a diagenetic BSR in the Dove Basin (southern Scotia Sea), suggested us to expand our analysis to other BSRs that have been recognized along some seismic profiles of the Antarctic region. We have focused on the correlation between the origin of the studied BSRs and the different sedimentary and tectonic environments where they developed.

In this study we present the analysis of 5 seismic reflection profiles, that have been acquired in Antarctic region by the R/V OGS Explora during the period 1989-1995.

All the recognized BSRs mimic the sea bottom topography and cross-cut the seismic reflectors, but the analysis of their seismic characteristics, as amplitude, phase and frequency components, allow to define their nature, i.e. fossil diagenetic due to transformation of Opal A/Opal CT, or gas hydrate.

Literature data show evidences of different BSRs in the Antarctic offshore: diagenetic BSRs have been recognized in the Scan Basin of south Scotia Sea (Somoza *el al.*, 2014), along the eastern margin of the South Orkney microcontinent (Lonsdale, 1990) and in the Antarctic peninsula offshore (Volpi *el al.*, 2003; Rebesco *el al.*, 1997); gas hydrate BSRs have been identified in the South Shetland Trench (Lodolo *el al.*, 2002) and in the Victoria Land Basin (Geletti and Busetti, 2011) in the Ross Sea.

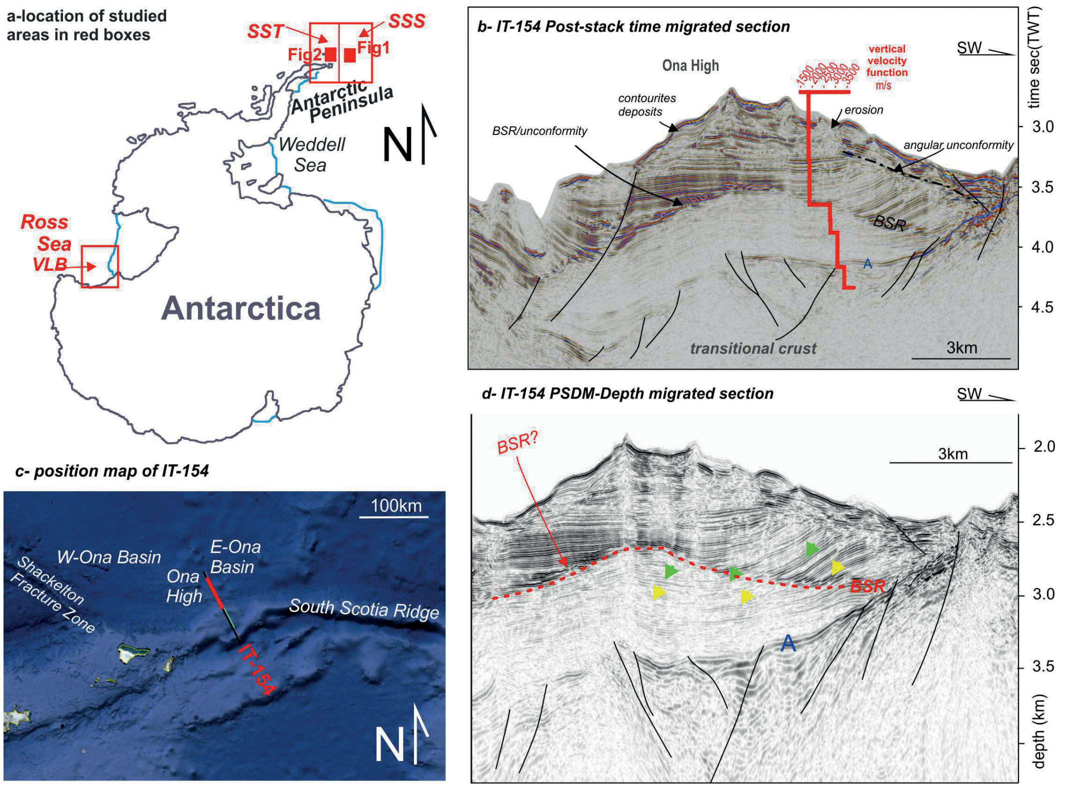

Fig. 1 – a) location of the study areas: SSS-South Scotia Sea, SST-South Schetland Trench, VLB-Victoria Land Basin; b) portion of seismic profile IT-154 crossing the Ona Basin-Ona High (location in c), where the red line represents the interval velocity trend through the observed BSR; d) pre stack depth migration where the arrows depict the continuity toward SW of sedimentary reflectors even through the BSR, while toward NE the BSR seems to coincide with an unconformity.

Three study areas have been considered in this paper (Fig. 1a):

1) oceanic and transitional crust of the South Scotia Sea (SSS), where the seismic profiles IT95-167 and IT-154 cross respectively the Dove Basin and the Ona Basin-Ona High;
2) the South Shetland Trench (SST), where the seismic profile IT90-A44 crosses the slope in NW-SE orientation;
3) the continental crust of the Victoria Land Basin (VLB) crossed by the seismic profiles IT90AR-63S and IT90AR-64S.

We show the seismic characteristics of the recognized BSRs and analyze their relationships with the geological setting of the studied zones, through re-processing of seismic data and new analysis with seismic attributes, AVO (Amplitude Variation with Offset) and P/ S wave reflectivity analysis.

Analysis of seismic data. The seismic profiles that cross the recognized BSRs have been re-processed, in order to extract all the useful information about seismic wave velocity, amplitude, phase, frequency, and burial depth. These parameters allow to perform a qualitative analysis and a BSR characterization.

We adopt a processing flow made up of preliminary interpretation, improved velocity analysis, post stack depth migration, seismic attribute and AVO analysis.

Study area 1 - South Scotia Sea. The nature of the BSR recognized in the Dove Basin has been ascribed to a fossil diagenetic origin, due to its seismic characteristics (no polarity inversion, velocity increasing) and burial depth between 600 and 700 m (Mocnik *et al.*, 2015).

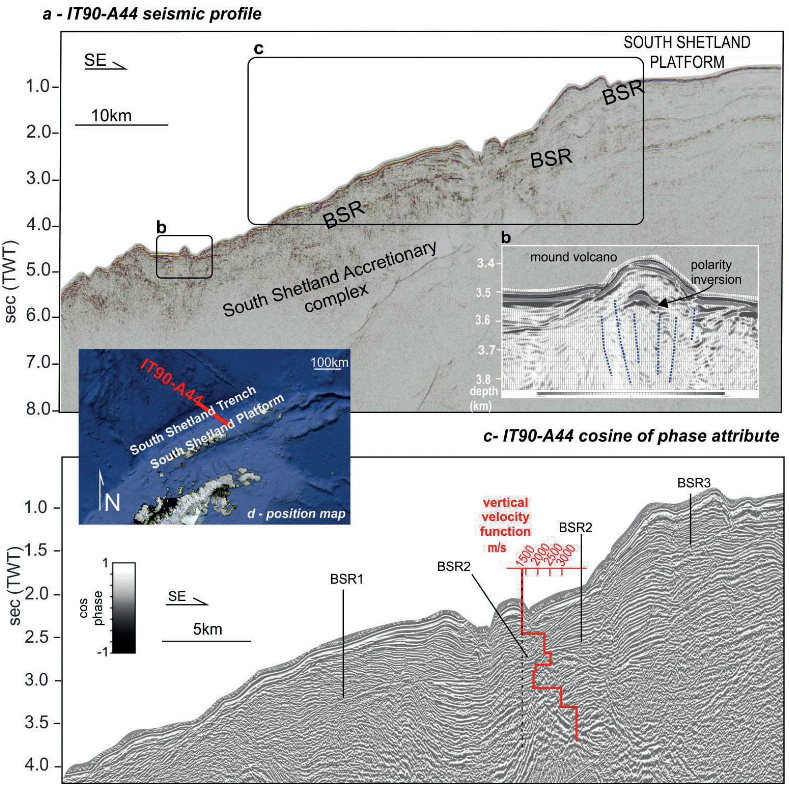

Fig. 2 – a) portion of seismic profile IT90-A44 (location in map d) from the South Shetland Platform (SE) toward the South Shetland Trench (NW) where three BSR have been highlighted. b) zoom on the mound volcano in the depth domain: the polarity inversion could be produced by the top of methane gas accumulation, migrated through the fault system of the South Shetland accretionary complex; c) the cosine of phase seismic attribute better discriminates the three segments of BSR; the example of the interval velocity function (red line) shows a drop of velocity below the BSR2.

The BSR identified along the seismic profile IT-154 (Fig. 1b) that crosses the sedimentary mound resting on the transitional crust of the Ona High (Civile *et al.*, 2012), shows similar characteristics. The BSR is almost parallel respect to the seabed topography and cross-cut the seismic reflectors of the sedimentary succession of the mound. The BSR amplitude is generated by a high contrast of acoustic impedance that produced a high energy absorption. The interval velocity (red line through the BSR) increases to more than 3000 m/s below the BSR, suggesting an increment of density. The BSR recognized in the NE sector of the mound could be an unconformity. This hypothesis is supported by the presence of onlap terminations of the seismic reflectors against the BSR. The depth migrated seismic profile (Fig. 1d) shows that the BSR is deeper than 500 m below the seabed. It also evidences the real dip of the reflectors, no more affected by pull-up effects (note the different dip of reflector A).

Study area 2 - South Shetland Trench. In this area, a methane hydrate related BSR has been already recognized by Lodolo *et al.*, (2002). The BSR is identified along the seismic profile IT90-A44 (Fig. 2), where it develops for about 20 km, from the South Shetland Platform (SE) to the trench (NW). The cosine of phase attribute (Fig. 2c) highlights its continuity and the overlying sedimentary sequence, which is an accretionary wedge. The velocity analysis showed a decrease of the velocity values below the BSR (red line superimposed). We also observed a decrease of the frequency component below it, mainly below BSR1. A mound shaped structure, about 100 m high above seabed, has been observed through the trench (Fig. 2b). A reverse polarity reflector is located at its base (-100 m from the top) and the central part of the mound is affected by faults with a symmetric configuration (blue dashed lines). This suggests that these structures could be a direct response to fluid escape.

Study area 3 – Ross Sea. Within the Victoria Land Basin new details have been focused on the BSR recognized by Geletti and Busetti (2011), along the seismic profiles IT90AR-63S and IT90AR-64S. The crossplot between the AVO gradient and intercept attributes confirms an anomalous trend respect to the surrounding sediments, probably produced by variations in fluid saturation; also the irregular trending of the interval velocity, characterized by velocity inversions within the sedimentary succession between the seabed and the BSR, could highlight a methane migration through the normal fault system that affect the Terror rift and Discovery graben.

Conclusions. This study presents the results deriving by the analysis of new and already described in literature BSRs, located in different sectors of the Antarctic offshore characterized by a different crustal domains: Dove Basin-Ona High (South Scotia Sea); South Shetland Trench; Victoria Land Basin (Ross Sea).

Fossil-diagenetic BSRs have been observed in the deep basins at a water depth of 2500-4000 m, where the temperature and pressure conditions are not favorable for methane hydrates.

On the South Shetland accretionary complex the recognized fault system seems to represent a preferred pathway for fluids migration. Fluids, probably originated also from the deep crust, can migrate toward the sea-bottom, as proved by the presence of a mud volcano.

In the continental domain the fault systems drive the fluid migration as testified by seabed structures produced by methane gas seeps and expulsion. Gases could have a biogenic origins from the organic matter contained in the shallower sediments.

This analysis is a contribution to the general understanding of formation of BSR in the Antarctic region by integration of seismic processing and interpretation, in particular within areas with no available borehole or calibration data.

Acknowledgements. The Italian Programma Nazionale di Ricerche in Antartide (PNRA) provided financial support for this work (VALFLU project). The authors gratefully acknowledge Paradigm though the OGS Focus and Geodepth processing software, and Schlumberger through the University of Trieste Petrel academic grant for interpretation software.

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