Report on the cruise participation CalaQuake14 in the Ionian Sea in May 2014 within the FLOW project

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Within the frame of the FLOWS project I participated on the cruise CalaQuake14 with the Italian research vessel URANIA from May 9th to May 25th, 2014 in order to undertake sedimentological and geochemical sampling on sediment cores and to analyze relationships between active tectonics, fluid flow, and sedimentation. The working area was the Ionian Sea (Fig. 1). The main objectives of the cruise were to get a better understanding of the structural geology, active faulting, and historical earthquakes in the Calabrian Arc (Ionian Sea). During the cruise we covered an area of about 850 km² by means of multibeam data and sub-bottom profiles (CHIRP) were recorded over a total length of 2300 km (Fig. 1). The geophysical data sets were used to find suitable coring location in order to meet the scientific objectives of the cruise.

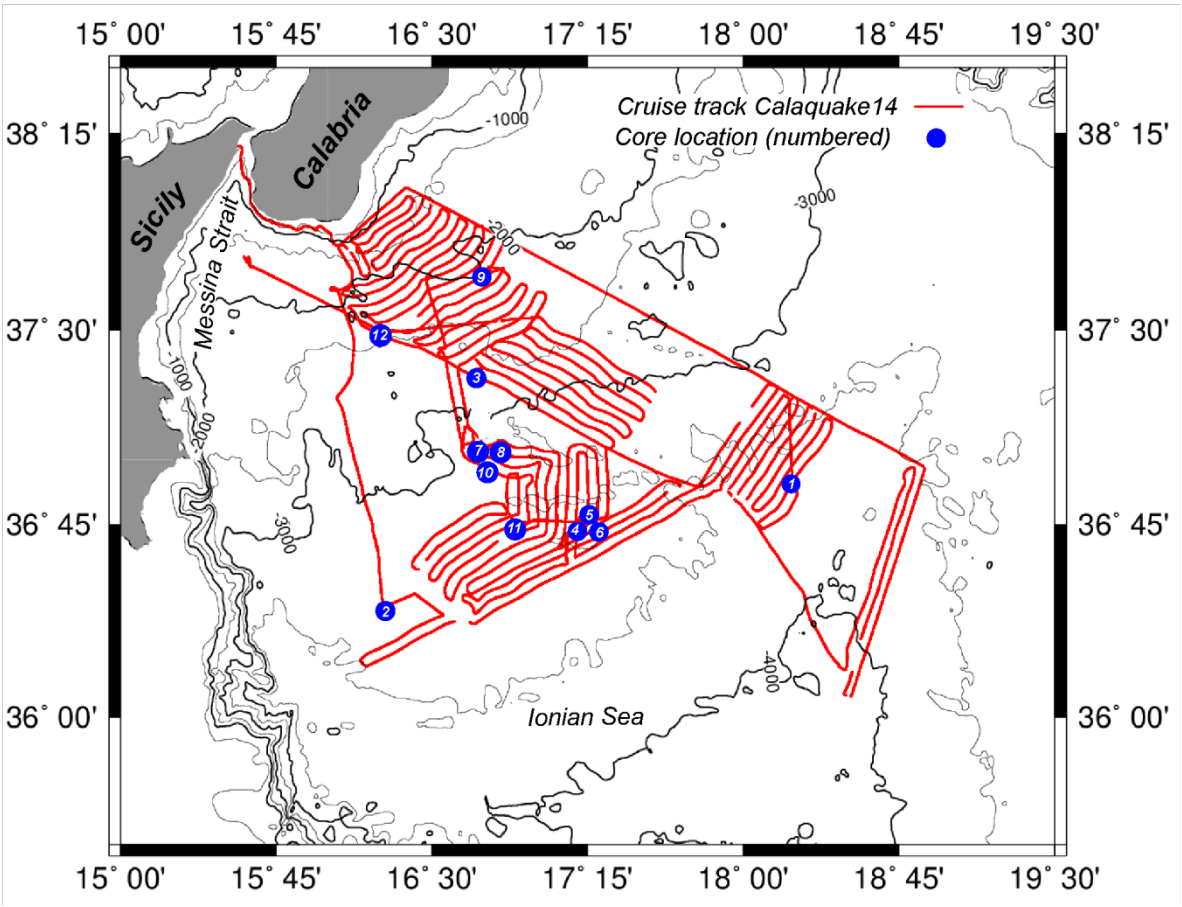

Figure 1: Track map of the cruise CalaQuake14 in May 2014 with the Italian Research Vessel URANIA.An overview of the sampled cores can be found in a table below

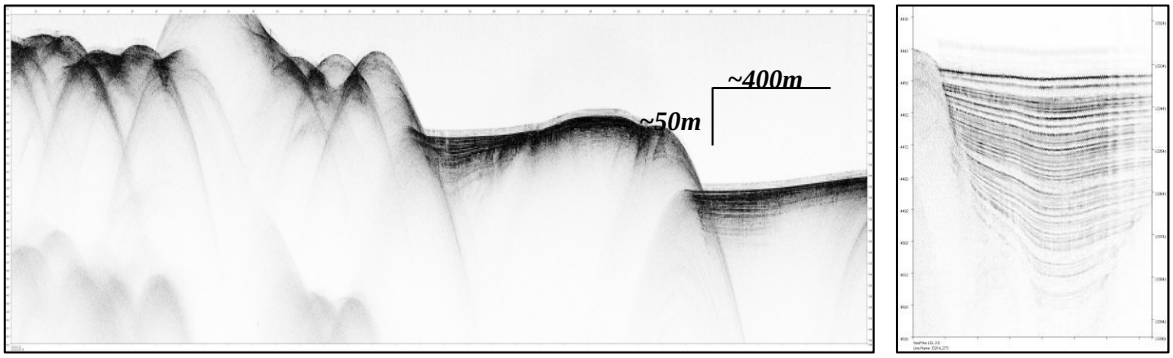

Figure 2: Example of a Chirp profile. (left) tectonically induced basins filled by sediments within an overall hummocky topography. (right) example of an infill characterized by layered sediments within a basin.

The study area is a complex geological region because affected by active tectonic processes related to the convergence between Africa and Eurasia along the Calabrian Arc. This produces a wide area of deformation where three main deeply rooted fault systems accommodate shortening and margin segmentation (Polonia et al., 2011; Polonia et al., 2012). The subduction complex shows two distinct structural lobes characterized by different deformation rates and depth of the detachment level.

The Ionian basin contains sedimentary sequences spanning from Jurassic to the present, that includes, in its upper part, about 2 km of Messinian (Late Miocene) evaporites overlain by Plio-Quaternary sediments mainly represented by turbidite layers.Sediment remobilization during the last millennia are mainly related to active tectonics and seismic shaking (Polonia et al., 2013a; Polonia et al., 2013b).

The area is also well-known for several mud volcanoes that have been identified on the seafloor Praeg et al., 2009; Panieri et al., 2013; Ceramicola et al., 2014). However, ages of such mud volcanoes are uncertain.

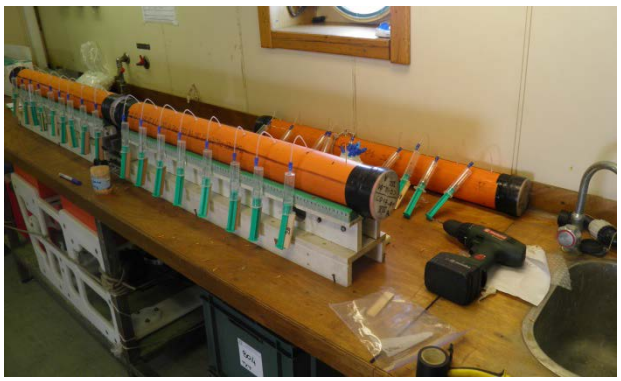

Figure 3: Photograph showing the pore water sampling in the lab on board of RV URANIA. We took samples every 10cm on the first core. In subsequent cores only 3 times per section were sampled.

Coring during Calaquake14 aimed to get insights for a better understanding of fluid flux and the origin of methane within the sediments. In total, 12 sediment cores were recovered and sampled at the bottom of each 1m-section immediately after cutting the entire sediment core on deck. Sedimentological sampling included 3 ml sediment extracted by a cut-off syringe and stored in a glass bottle with 9 ml saturated salt water. The glass bottle had to be closed tidely to prevent any loss of methane and other gases from the sediments. Additionally, 3 ml of sediment was stored in a pre-weighted plastic tube to obtain the porosity of the sediment at each section. Unfortunately, we ran out of

those pre-weighted cups while sampling core CQ14_07. Hence we took some more sample material in the plastic bottle that was meant to analyze the absorbed gases (10 g). The first step onboard in the lab was the measurement of magnetic susceptibility on each section by means of a Bartington MS2. Values for magnetic susceptibility were then used as a first tool to guide pore-water sampling and stratigraphic correlation because pattern of magnetic susceptibility curves within this region are well-known and can be correlated to the stratigraphy of the uppermost sediments. For example, the so called HAT, a Megaturbidite that can be found in the deeper parts of the Ionian Sea is characterized by gently increasing values of magnetic susceptibility with a sudden decrease below its base (Polonia et al., 2013a). Using this interpretation we assumed to cover the entire HAT in core CQ14_01. This specific core were subsequently sampled every 10 cm by means of pore-water sampling. All remaining cores were sampled 3 times within each section and, with some exception in very short cores, we sampled at 25 cm, 50 cm, and 75 cm core depth of each section. All pore-water samples were subsampled onboard in order to extract material for measuring the content of isotopes, trace metals (ICP-AES), and the geochemistry of the sediments. All samples were stored in a fridge onboard and shipped to GEOMAR Kiel immediately after arriving in Naples.

NAME	LON(ddmm.)E	LAT(ddmm.) N	Depth	Heading	Penet.(m)	Recover (m)
CQ14_01	1814.146828	3654.80146	3793	258	10	8.4
CQ14_02	1617.627214	3626.28346	3356	185	7	6.7
CQ14_03	1642.950897	3720.962858	2752	247	10	7.16
CQ14_04	1712.448302	3645.354277	3473	327	10	7.6
CQ14_05	1711.786741	3645.430651	3472	280	10	8.05
CQ14_06	1714.433312	3645.140663	3417	271	10	7.76
CQ14_07	1645.723147	3702.436100	3465	144	10.2	7.44
CQ14_08	1645.538338	3703.041039	3310	102	7.8	7.22
CQ14_09	1646.693486	3743.850847	2273	106	8	5.54
CQ14_10	1645.349874	3704.085527	3090	237	10	7.8
CQ14_11	1654.430564	3644.133826	3333	283	10	8.38
CQ14_12	1615.945932	3729.404166	2257	322	3.5	2.14

Table 3. Cores collected during CALAQUAKE2014, location, penetration, etc.

Geochemical analysis of pore water and sediments can contribute to explain the origin of methane in the sediments, e.g. by their isotopic signature. High methane content is a good indicator for recent activities and fluids rising up along active faults and subsequently erupting in mud volcanoes.

References

CERAMICOLA, S., PRAEG, D., COVA, A., ACCETTELLA, D. & ZECCHIN, M. ***(2014)*** *Seafloor Distribution and Last Glacial to Postglacial Activity of Mud Volcanoes on the Calabrian Accretionary Prism, Ionian Sea. Geo-Marine Letters, 34, 111-129.*

PANIERI, G., POLONIA, A., LUCCHI, R., ZIRONI, S., CAPOTONDI, L., NEGRI, A. & TORELLI, L. ***(2013)*** *Mud Volcanoes Along the Inner Deformation Front of the Calabrian Arc Accretionary Wedge (Ionian Sea). Marine Geology, 336, 84-98.*

POLONIA, A., BONATTI, E., CAMERLENGHI, A., LUCCHI, R.G., PANIERI, G. & GASPERINI, L. ***(2013a)*** *Mediterranean Megaturbidite Triggered by the Ad 365 Crete Earthquake and Tsunami. Scientific reports, 3.*

POLONIA, A., PANIERI, G., GASPERINI, L., GASPAROTTO, G., BELLUCCI, L. & TORELLI, L. ***(2013b)*** *Turbidite Paleoseismology in the Calabrian Arc Subduction Complex (Ionian Sea). Geochemistry, Geophysics, Geosystems, 14, 112-140.*

POLONIA, A., TORELLI, L., MUSSONI, P., GASPERINI, L., ARTONI, A. & KLAESCHEN, D. ***(2011)*** *The Calabrian Arc Subduction Complex in the Ionian Sea: Regional Architecture, Active Deformation, and Seismic Hazard. Tectonics, 30.*

PRAEG, D., CERAMICOLA, S., BARBIERI, R., UNNITHAN, V. & WARDELL, N. (2009) *Tectonically-Driven Mud Volcanism since the Late Pliocene on the Calabrian Accretionary Prism, Central Mediterranean Sea. Marine and Petroleum Geology, 26, 1849-1865.*