



## **Project of Strategic Interest NEXTDATA**

Scientific report  
for the reference period 01-01-2014 / 31-12-2014

### **W.P1.5 Paleoclimate data from marine sediments**

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## 1. Planned activities and expected results

The research activities performed during the third Project year, as specified in the Executive Plan, include the integrated study of the marine sediments recovered during the Oceanographic Cruise “NEXTDATA-2013” in selected areas of the Mediterranean (Sicily Channel and Gulf of Taranto). This study will be focused on the identification of the main paleoclimatic oscillations (from decadal to secular scale), recognized at the global scale during the last 2000 years, through calcareous plankton analyses (planktonic foraminifera and calcareous nannofossils), geochemical analyses ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ , Mg/Ca performed on selected planktonic foraminiferal species) and sedimentological analyses. The succession of the paleoclimatic events recognized in the key sites of study, will be compared with the climatic oscillations documented in other sectors of the Mediterranean basin, to understand the age and the time of these events. This procedure will allow us to propose an Event Stratigraphy processing for the Mediterranean area to be completed at the end of NextData Project.

Milestone M1.5.3 (PM24): First results of the analysis carried out on the marine cores stored in the *core repository*.

## 2. Deliverables planned for the reporting period

D1.5.3: Report on the marine cores and on the analysis of the data; transmission of data to archives and to the General Portal.

## 3. Activities actually carried out during the reporting period

The research activities developed during the third year of the Project have been focused on the paleoclimatic reconstruction for the last two millennia of the central Tyrrhenian Sea (Core SW104\_C5-C5, Gulf of Gaeta) and on the analysis (calcareous plankton, stable isotope, tephra layers and paleomagnetism) of the marine cores ND14O\_SW104 (Gulf of Taranto), ND11\_SW104 (Sicily Channel) and ND-14Q\_SW104 (south Adriatic Sea) for past climate reconstruction.

A new research activity on central Tyrrhenian Sea (core SW104\_C5-C5, Gulf of Gaeta) has been focused on past runoff reconstruction from Reworked Coccoliths that are known to be directly correlated to continental runoff. During the third year of the Project, the following new cores - GIOVE\_4, GIOVE\_5, ND\_14M\_bis, ND\_14O, ND\_14Q, ND\_14R, ND\_14S, ND\_14T, ND\_14U, ND\_14V, ND8\_2014, ND11\_2014 - have been collected in the Adriatic Sea and Gulf of Taranto, during the oceanographic cruise “NEXTDATA-2014” by IAMC-CNR aboard the CNR R/V Urania in July 2014. In addition, as a contribution to the “*Grand Challenge - Italy2K*” of the NextData Project, we collected data and metadata from 21 marine cores, close to the Italian peninsula. The associated metadata are available on the NextData web page (<http://www.nextdataport.it/?q=it/content/italy-2k>). These literature data, combined with new marine data collected during the NextData Project, will be used to generate maps of Sea Surface Temperature (SST) for different time windows during the last 2 millennia. Furthermore, pollen maps for the Holocene (last 11ka) and covering the Italian territory have been created with a time resolution of 500 years using a database of hundred pollen records. These maps have been produced in cooperation with the Laboratory of Palynology and Palaeoecology of the National Research Council (CNR, Milan) and the Laboratory of Palaeobotany and Palynology of the University of Rome, La Sapienza.

We have also fostered partnerships with foreign groups of researchers who are leading integrated analyses of marine cores in selected areas of the Mediterranean basin, to identify the climatic oscillations of the last two millennia. Specifically, we have established contacts with the following researchers: Marie-Alexandrine Sicre (Laboratoire des Science du Climat et

de l'Environnement, CNRS) and Belen Martrat (DAEA-CSIC, Department of Environmental Chemistry, University of Barcelona) for the analysis of the alkenon (proxy for SST reconstruction) and Isabel Cacho (University of Barcelona) for the analysis of Mg/Ca ratio (proxy for SST reconstruction). These collaborations will be performed under the umbrella of the network "Pages".

### *3.1 Research activities*

#### *3.2 Application, technological and informatic developments*

Development, documentation, testing and release of the "Scoter" software for high-resolution palaeomagnetic dating by correlation of relative palaeointensity and palaeosecular variation curves.

#### *3.3 Training activities*

In the third year of the NextData Project, a second Research Fellowship year has been extended for Dr. Giulia Margaritelli, in order to conduct "paleoclimate and paleoecological analysis of sediments in the Mediterranean basin over the last 2000 years, based on the integration of quantitative data derived from planktonic and benthic foraminiferal assemblages". A PhD position for Dr. Stefania Sorgato has started on "Study of the calcareous nannofossils as bio-indicators of the climatic oscillation recorded in the Mediterranean during the last 2000 years". PhD School "Science applied at Sea, Environment and territory" – curriculum "Science of Sea, Earth and Climate", XXIX cycle at Università degli Studi di Napoli Parthenope.

In January 2014, a post-doctoral contract at INGV Rome was initiated for Dr. Pontus C. Lurcock to be carried out in collaboration with Dr. Fabio Florindo, aimed at the study of the palaeomagnetism and magnetic mineralogy of sequences drilled during NextData and development of the software for stratigraphic correlation and stacking of relative palaeointensity curves.

#### *3.4 Dissemination*

The NextData Project has been included in the ongoing RCMNS Project of the 2014 RCMNS (Regional Committee on Mediterranean Neogene Stratigraphy) Bulletin, edited by the Natural History Museum of Vienna. In addition, the WP 1.5 research activities have been presented and illustrated at *Pages meeting* in Soria, Spain, 14-17 september 2014.

#### *3.5 Participation in conferences*

Convegno Accademia dei Lincei, *Climate variability in Italy during the last two millennia – Italy 2k*, Roma, Italy, 1-2 December 2014.

European Geosciences Union - *General Assembly 2014*. Vienna, Austria, 27 april – 2 may 2014.

Joint Congress of Società Geologica Italiana (SGI) and Società Italiana di Mineralogia e Petrologia (SIMP). *The Future of the Italian Geosciences -The Italian Geosciences of the Future*. Milano, Italy, 10-12 September 2014.

9° *European Palaeobotany Palynology Conference*, Padova, Italy, 26-31 August 2014.

14° *New trends on Paleo, Rock and Environmental Magnetism. Castle Meeting* (<https://www.fc.ul.pt/pt/conferencia/14th-castle-meeting>), Évora, Portugal 31 August - 6 September 2014,.

## 4. Results obtained during the reference period

### 4.1 Specific results (databases, measurements results, models output, etc)

The analysis performed in this WP on the core SW104\_C5-C5 (Gulf of Gaeta) allowed us to recognize and date the main climatic oscillations occurred over the last two millennia (Fig. 1): *Roman Period* (top interval ca. 530 AD), *Dark Age* (ca. 530 – ca. 840 AD), *Medieval Classic Anomaly* (ca. 840 – ca. 1240 AD), *Little Ice Age* (ca. 1240 – ca. 1850 AD), *Industrial Period* (ca. 1850 – ca. 1940 AD), *Modern Warm Period* (ca. 1940 AD). These climatic oscillations, calibrated with high-resolution age model, have been identified by comparing  $\delta^{18}\text{O}$  *G. ruber* signal with the planktonic foraminiferal turnovers between carnivorous (*Globigerinoides ruber*, *G. quadrilobatus*, *Orbulina* spp., *Globigerinatella siphonifera*) and herbivorous-opportunistic species (*Turborotalita quinqueloba*, *Globigerinita glutinata*, *Globigerina bulloides*).

The paleoclimatic reconstruction of the SW104\_C5-C5 core allowed us to recognize the following intervals:

- the *Roman Period* is characterised by two cold phases (Roman I and Roman III) interlayered by a warm one. At the top of this period, a first turnover from carnivorous to herbivorous-opportunistic planktonic foraminiferal species marks the Roman Period-Dark Age transition;
- the *Dark Age* is characterised by a first warm phase followed by a cold one (Roman IV);
- the *Medieval Classic Anomaly period* is characterised by an overall stable climatic condition;
- at ca. 1240 AD a planktonic foraminiferal turnover documented the transition between the *Medieval Classic Anomaly* and the *Little Ice Age*. During Maunder event, the strong increase in *G. truncatulinoides* and *G. inflata* abundances, suggest an increase in deep mixed layers during winter. Strong winds caused by Atlantic blocking may be responsible for mixing water, resulting in the rapid spread of these planktonic foraminiferal species.
- The *Industrial Period* is characterized by an increase in abundance of warm water species *G. quadrilobatus* and *G. ruber*.
- The last planktonic foraminiferal turnover documented the onset of Modern Warm Period. During this interval, the  $\delta^{18}\text{O}$  *G. ruber* signal documents warming and more diluted seawater condition. In addition, from ca. 1950 AD upwards, the modern warm climatic phase and oligotrophic conditions are documented by a further strong increase in *G. ruber* pink and *G. quadrilobatus* abundances.

The comparison between the SST reconstructed from  $\delta^{18}\text{O}$  *G. ruber* signals from Gulf of Gaeta (central Tyrrhenian Sea), Gulf of Salerno (Lirer et al., 2014, south Tyrrhenian Sea), Gulf of Taranto (Grauel et al., 2013) and Menorca Basin (Moreno et al., 2012) show a high correlation of both trends and values. This parallelism is also found in the continental data from the Alps (Wirth et al., 2013), cave in Turkey (Gokturk et al., 2001) and cave in Austria (Mangini et al., 2005), suggesting a climate connection (solar forcing) between different environments. Spectral and wavelet analysis carried out of reworked coccoliths and AMO index documented a distinct peak at ca 80 yr. The comparison of filtered signals at the 80 yr frequency band revealed a strong correlation between the Volturno river runoff and the AMO index during the last 350 years. This feature supports the hypothesis that the reworked coccoliths can be effectively used to reconstruct the past runoff oscillations. We produced pollen maps of several tree taxa, including *Picea*, *Abies*, *Betula*, *Fagus*, *Carpinus betulus*, *Corylus*, *deciduous and evergreen Quercus*, and *Olea*. In addition, pollen maps of arboreal vegetation have been created (with time windows of 500 years). Overall, a progress of knowledge on the past vegetational features of Italy has been attained as well as a better understanding of the

modern vegetation, which often shows complex patterns that can be traced back in time over several thousands of years. Although the available distribution maps for modern tree taxa in Italy need to be refined and pollen data are still missing from large areas of Italy, complex patterns and discontinuous ranges of modern tree taxa can be traced back in time over several thousands of years. Water availability appears to be a major factor influencing not only the modern distribution of trees, but also their past evolution. The tree cover was generally higher in the regions with higher orographic precipitation with respect to dry areas. This is not always depending on their latitudinal location. For example, it appears that the rainy mountains of Calabria in South Italy have been more forested than the relatively dry sites in the Aosta Valley (NW Italy) during the Holocene.

#### 4.2 Publications

LIRER F., SPROVIERI M., VALLEFUOCO M., FERRARO L., PELOSI N., GIORDANO L., CAPOTONDI L., (2014): Planktonic foraminifera as bio-indicators for monitoring the climatic changes occurred during the last 2000 years in the SE Tyrrhenian Sea. *Integrative Zoology*. DOI: 10.1111/1749-4877.12083.

MAGRI, D., AGRILLO, E., DI RITA, F., FURLANETTO G., PINI R., RAVAZZI C., & SPADA F. (2014): Holocene dynamics of tree taxa populations in Italy. *Review of Palaeobotany and Palynology*. DOI: 10.1016 / j.revpalbo.2014.08.012.

GRANT K.M., ROHLING E.J., BRONK RAMSEY C., CHENG H., EDWARDS R.L., FLORINDO F., HESLOP D., MARRA F., ROBERTS A.P. TAMISIEA M.E., and WILLIAMS F., (2014): Sea-level variability over five glacial cycles. *Nature Communications*. DOI: 10.1038/ncomms6076.

MARRA F., FLORINDO F., (2014): The subsurface geology of Rome, Italy. Relationship among sedimentary processes, sea-level changes and astronomical forcing. *Earth-Science Reviews*. DOI: 10.1016/j.earscirev.2014.05.001.

MENSING S., TUNNO I., SAGNOTTI L., FLORINDO F., NOBLE P., ARCHER C., ZIMMERMAN S., PAVÓN-CARRASCO, F.-J., CIFANI G., PASSIGLI S., PIOVESAN G., (in press): 2700 years of Mediterranean environmental change in central Italy: a synthesis of sedimentary and cultural records to interpret past impacts of climate on society. *Quaternary Science Reviews*.

NEGRI A., AMOROSI A., ANTONIOLI F., BERTINI A., FLORINDO F., LURCOCK P. C., MARABINI S., MASTRONUZZI G., REGATTIERI E., ROSSI V., SCARPONI D., TAVIANI M., ZANCHETTA G., VAI G. B., (2014): A potential global boundary stratotype section and point (GSSP) for the Tarentian Stage, Upper Pleistocene, from the Taranto area (Italy): Results and future perspectives, *Quaternary International*. DOI: 10.1016/j.quaint.2014.08.057.

BONOMO S., LIRER F., FERRARO L., ALBANO L., ALBERICO I., ANZALONE E., BARRA R., CASCELLA A., CASTELLANO M., DI STEFANO E., D'ORIANO C., FERRARO R., GIORDANO L., LURCOCK P.C., MARGARITELLI G., MARSELLA E., PELOSI N., PUNZO M., VALLEFUOCO M., TARALLO D., ZARCONE G., (2014): *Core description collected during Oceanographic Survey: NEXTDATA-2013 (12 – 19 september 2013) - Strait of Sicily - Gulf of Taranto. CNRSOLAR, identification code 4517TR2014.*

LIRER F., MARGARITELLI G., VALLEFUOCO M., BONOMO S., CAPOTONDI L., CASCELLA A., DI RITA F., FERRARO, L., INSINGA D.D., MAGRI D., MARSELLA E., PETROSINO P., RETTORI R., (2014): Climatic variability during the last two millennia in the Tyrrhenian Sea: evidence from marine sediments. *Convegno Accademia dei Lincei, Climate variability in Italy during the last two millennia – Italy 2k*, Roma 1-2 december 2014.

ALBERICO I., FERRARO L., LIRER F., ANZALONE E., VALLEFUOCO M., BONOMO S., CASCELLA A., PETROSINO P., INSINGA D.D., BARRA R. & MARSELLA E., (2014): Marine sediment cores: archive of the

Mediterranean Basin. A tool for Holocene climatic and environmental studies. *CONGRESSO SGI-SIMP 2014. Rend. Online Soc. Geol. It.*, 31 (1).

BONOMO S., CASCELLA A., ALBERICO I., FERRARO L., LIRER F., VALLEFUOCO M., ANZALONE E. & MARSELLA E., (2014): Reworked coccoliths: proxy to reconstruct Volturno hydrographic basin runoff variation. *CONGRESSO SGI-SIMP 2014. Rend. Online Soc. Geol. It.*, 31 (1).

LIRER F., MARGARITELLI G., VALLEFUOCO M., AGNINI C., ANZALONE E., BELLUCCI L., BONOMO S., CASCELLA A., DI RITA F., FERRARO, L., INSINGA D.D., MAGRI D., MARSELLA E., PAPPONE G., CAPOTONDI L., PETROSINO P., RETTORI R., SORGATO S., (2014): Paleoclimatic changes occurred during the last two millennia in the central and south Tyrrhenian Sea: a contribution of NextData Project. *CONGRESSO SGI-SIMP 2014. Rend. Online Soc. Geol. It.*, 31 (1).

LIRER F., VALLEFUOCO M., ALBERTAZZI S., ANZALONE E., BELLUCCI L., BONOMO S., CAPOTONDI L., CASCELLA A., DI RITA F., FERRARO, L., FLORINDO F., GIULIANI S., INSINGA D.D., LURCOCK P., MAGRI D., MARGARITELLI G., MARSELLA E., PETROSINO P., SPROVIERI M., SORGATO S., (2014): Paleoclimatic changes occurred during the last two centuries in the Gulf of Gaeta (central-eastern Tyrrhenian Sea): a contribution of NextData Project. Vol. 16, EGU2014-12119, 2014.

LURCOCK P.C. and FLORINDO F., (2014): New stability test for high-resolution palaeomagnetic data, Vol. 16, EGU2014-194-1, 2014.

#### 4.3 Availability of data and modelling output (format, support, etc.)

- Planktonic foraminiferal quantitative data from cores: C5-C5\_SW104 and C6 (Gulf of Gaeta, central Tyrrhenian Sea), ND11\_SW104 (Sicily Channel), ND14O\_SW104 (Gulf of Taranto), ND11\_SW104 (Sicily Channel) and ND-14Q\_SW104 (south Adriatic Sea). These data have been uploaded to the General Portal.
- Quantitative calcareous nannofossil data from cores: ND11\_SW104 and ND2 (Sicily Channel) and C5-C5\_SW104 (Gulf of Gaeta, central Tyrrhenian Sea). These data have been uploaded to the General Portal.
- Planktonic foraminifer (*Globigerinoides ruber*)  $\delta^{18}\text{O}$  data from cores: C5-C5\_SW104 (Gulf of Gaeta, central Tyrrhenian Sea), ND11\_SW104 (Sicily Channel) and ND-14Q\_SW104 (south Adriatic Sea). These data have been uploaded to the General Portal.
- Quantitative pollen data of composite core C5-C5\_SW104 (Gulf of Gaeta, central Tyrrhenian Sea). These data have been uploaded to the General Portal.
- Magnetic susceptibility data from cores: (GIOVE\_4, GIOVE\_5, ND\_14M\_bis, ND\_14O, ND\_14Q, ND\_14R, ND\_14S, ND\_14T, ND\_14U, ND\_14V, ND8\_2014, ND11\_2014). These data have been uploaded to the General Portal.
- Numerical data from literature: AD 91-17 (Planktonic foraminifera, Carbon and Oxygen stable isotopes in *G. bulloides*), BS7938 (Planktonic foraminifera, Carbon and Oxygen stable isotopes in *G. ruber* and *G. bulloides*), BS7937 (Planktonic foraminifera, Carbon and Oxygen stable isotopes in *G. ruber* and *G. bulloides*), BS7933 (Oxygen stable isotopes in *G. bulloides*, UK37\_SST), C18 (Planktonic foraminifera), DP30 (Carbon and Oxygen stable isotopes in *G. ruber*), ET 91-18 (Planktonic foraminifera, Carbon and Oxygen stable isotopes in *G. ruber*), GeoB10709-4 (Carbon and Oxygen stable isotopes in *G. ruber* and *U. mediterranea*), GT 85-5 (Planktonic foraminifera, Carbon and Oxygen stable isotopes in *G. bulloides*), MD90-17 (Carbon and Oxygen stable isotopes in *G. bulloides*), ST407 (Calcareous nannofossils), ST272 (Calcareous nannofossils), ST342 (Calcareous nannofossils), NU04 (Carbon and Oxygen stable isotopes in *G. ruber* (pink and white) and *U. mediterranea*, SST), NK2 (Planktonic foraminifera), RF93-30 (Planktonic foraminifera).
- Transmission of paleomagnetic measurements data to the archives and to the General Portal.



#### 4.4 Completed Deliverables

D1.5.3: Report on the marine cores and on the analysis of the data; transmission of data to archives and to the General Portal.

The literature data from Mediterranean marine sediments useful for the paleoclimatic reconstruction of the last 2000 years are based on 24 marine cores, coming from different sectors of the Mediterranean basin (Capotondi et al., 1999; Cacho et al., 2001; Schilman et al., 2001; Giunta et al., 2003; Oldfield et al., 2003; Sbaffi et al., 2004; Amore et al., 2004; Incarbona et al., 2010; Nieto-Moreno et al., 2012; Nieto-Moreno et al., 2013; Grauel et al., 2013; Grauel et al., 2013; Siani et al., 2013; Lirer et al., 2014; Di Bella et al., 2014; Goudeau et al., 2014; Morabito et al., 2014). The NextData Project contributed to this database with seven new cores located in the central and south Tyrrhenian Sea, Sicily Channel, Gulf of Taranto and South Adriatic Sea. During 2015 and 2016 the NextData Project will produce new numerical data for new cores (central and north Adriatic Sea), useful for paleoclimatic studies..

The analysis of the new data acquired for NextData Project allowed us to identify and to date six climatic phases. In addition, the comparison between the SST reconstructed from  $\delta^{18}\text{O}$  *G. ruber* signals from Gulf of Gaeta (central Tyrrhenian Sea), Gulf of Salerno (south Tyrrhenian Sea), Gulf of Taranto and Menorca Basin show a high correlation of trends and values. This parallelism is also visible looking at the continental data from Alps, cave in Turkey and in Austria, suggesting a climate connection (solar forcing) between different environments.

The review of the marine core literature data documented that the high-resolution numerical data for the last 2000 years are few and scattered around the Mediterranean area. The complete list of metadata (planktonic foraminifera, calcareous nannofossils, stable isotope and alkenones), recovered from literature data is available on NextData home page (<http://www.nextdataport.it/?q=it/content/italy-2k>). All metadata are associated with correspondent numerical data. We have collected 8 useful data for SST reconstruction closed to Italy (Gulf of Gaeta, Gulf of Salerno, Sicily Channel, Gulf of Taranto, south Adriatic Sea).

All the acquired data from the literature and from new marine cores collected during the NextData Project have been uploaded to the archives and to the General Portal.

#### **5. Comment on any discrepancies between activities / results / Deliverables planned and actually realized**

The research activities for the third year of the Project were in accordance with the executive plan. In addition, we anticipated a research activity, planned for the fourth year of the Project. In particular, within a joint research with Marie-Alexandrine Sicre (Locean-CNRS Paris), we concluded the analysis of alkenones for Sea Surface Temperature reconstruction of core ND-14Q-SW104 (south Adriatic Sea). For this core an accurate age model with the recognition of three tephra layers documented in the core and associated with 1631 AD, 472 AD and 79 AD Vesuvius volcanic events. In addition, a master thesis on planktonic foraminifera, carried out on this core, documented the main climatic oscillation for the last two millennia.

#### **6. Planned activities for the following period**

The research activities for the fourth year of Project include a new oceanographic cruise, NEXTDATA-2015, aboard the CNR R/V Urania from September, 17th to October, 5th 2015. During this oceanographic cruise, new marine sedimentary cores will be recovered, within a joint proposal with the three international research groups (Prof. Isabel Cacho of University of Barcelona; Prof. Francisco Sierro of Salamanca University and Marie-Alexandrine Sicre, Locean-CNRS Paris), in different sectors of the Ionian Sea and of the eastern Mediterranean with the goal of recognizing and dating a succession of climatic events for the last two

millennia. In addition, water samples will be taken during this cruise to measure the  $\delta^{18}\text{O}_w$  values necessary for the SST reconstruction.

During this period, selected marine cores recovered through the Oceanographic cruise. The data collected during the NEXTDATA-2014 cruise in the Adriatic Sea will be studied. This integrated study will be focused on the main paleoclimatic oscillations occurred during the last 2000 years at decadal to secular timescales, within a high-resolution chronological framework. The succession of paleoclimatic events, documented through the geochemical analyses (performed on selected planktonic foraminiferal species), the sedimentological analyses and the study of biotic content (calcareous plankton and pollens), will be compared with the sequence recognized in other key sites recovered during the previous NextData oceanographic cruise, with other marine cores available in the western Mediterranean area and with continental data. This comparison will produce a complete picture of the climatic oscillations documented during the last two millennia in the Mediterranean basin.

During the fourth year, the acquired numerical data will be uploaded into the General Portal.

In addition, three PhD positions and one Post Doc have been created for the Nextdata Project:

- PhD thesis focused on “Study of the calcareous nannofossils as bio-indicators of the climatic oscillation recorded in the Mediterranean during the last 2000 years”. PhD School “Science applied at Sea, Environment and territory” – curriculum “Science of Sea, Earth and Climate” XXIX cycle at Università degli Studi di Napoli Parthenope;
- PhD thesis focused on “Study of the climatic oscillation recorded in the Mediterranean during the last 2000 years using the planktonic foraminifera”. PhD School in Science and Technology for Physics and Geology XXIX cycle at Università degli Studi di Perugia.
- PhD thesis focused on “Study of the climatic oscillation recorded in the Mediterranean during the last 2000 years using the planktonic foraminifera”. PhD School “Science applied at Sea, Environment and territory” – curriculum “Science of Sea, Earth and Climate” XXX cycle at Università degli Studi di Napoli Parthenope.
- Extension of the postdoctoral grant for Dr. Pontus C. Lurcock focused on the study of the paleomagnetism and magnetic mineralogy of sequences recovered during the Nextdata Project and development of software for stratigraphic correlation and stacking of relative paleointensity curves.