Project of Strategic Interest NEXTDATA

Scientific Report for the reference period 01/05/2013 – 31/12/2013

WP 1.6 Paleoclimatic data from continental regions

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The activities of WP 1.6 refer to the two Special Projects

P6. Multi-proxy reconstruction of Eastern Alpine Holocene climate
(coordinated by C. Barbante, CNR-IDPA)

P5. The use of sedimentary proxies in high altitude lakes for inferring the environmental changes during the late Holocene
(coordinated by A. Lami, CNR-ISE)

1. Scheduled activities, expected results and Milestones

Special Project P6:

- Processing of the Ortles firn/ice core
- Starting of δD and $\delta^{18}O$ analysis of the Ortles core
- Processing of the Danta di Cadore and Coltrondo peat bog cores
- Physical determination of the Danta di Cadore and Coltrondo peat bog cores
- XRF-CS analysis of the Danta di Cadore peat bog
- ICP-MS trace elements and Pb isotopes analysis of the Danta di Cadore peat bog

Special Project P5:

During the first months, the planned activity was focused on data collection of the several study sites existing in the Alpine mountains; the aim was to check data consistency and to identify the knowledge gap, in order to better document the natural variability at decadal and centennial periods. At the same time, we explored the possibility for a co-operation (e.g. exchange of information, data and eventually joint activity) with other research groups based in France, Austria and Switzerland. For this purpose, archives and scientific literature have been thoroughly reviewed to identify all suitable Italian high altitude sites where cores have been retrieved.

2. Deliverables expected for the reference period

No Deliverables are due for this reference period.

3. Activities which have been actually carried out during the reference period

3.1 Research activities

Special Project P6:

The Ortles firn / ice core has been processed by cutting 114 sections, each one 0.70m long, into subsamples for stable isotopes, pollen, therpens discrete analysis, as well as for the continuous flow analysis. Samples were cut with a modified commercial band saw, with a stainless steel blade and a polyethylene tabletop and guides. The table, guides and the blade were carefully cleaned with acetone and methanol to remove contamination before every use. All exposed ice surfaces were rapidly scraped with a stainless steel knife cleaned with 0.1% ultra-pure HNO_3 (Romil, Cambridge, UK), rinsed several times and carefully dried after each use. A specific cutting scheme has been developed in order to achieve subsamples characterized by a suitable geometry for the subsequent chemical analysis and, at the same time, to minimize the handling and cuts (Fig. 1).

For stable isotopes, therpens and pollens, the depth of the cutting resolution has been modified in order to achieve a sub-annual resolution along the entire core. A total of more than 2300 and 1980 samples have been prepared for stable isotopes and therpens respectively (Tab. 1). For the continuous flow analysis (CFA) the core sections were cut to obtain ice with a cross-section of 32x32 mm and a length of 30-70 cm, depending on the core conditions.

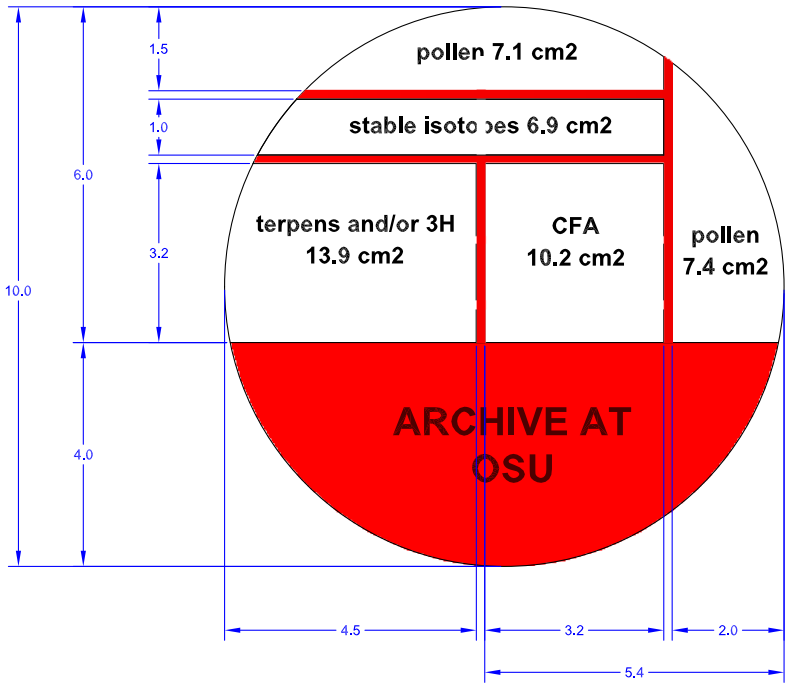

Fig. 1 Ortles ice core cutting scheme

Depth (m)		Stable isotopes		Pollens and therpens	
from	to	Resolution (cm)	# samples	Resolution (cm)	# samples
0.0	5.6	9	62	9	62
5.6	9.8	8	53	8	53
9.8	14.1	7	61	7	61
14.1	18.4	6	72	6	72
18.4	22.0	5	72	5	72
22.0	38.4	4	410	4	410
38.4	56.0	3	587	3	587
56.0	76.1	2	1000	3	667
		SUM	2316	SUM	1983

Tab. 1 Summary of Ortles discrete samples

During the drilling field campaign, the drilling of the core #1 has been suddenly stopped at 71.1m owing to a drill damage. When we started again after a couple of days, the borehole was partially closed by the refreezing of the melt water which was percolating from the firn part. The second drilling started at 65.5 m. and stopped just above the bedrock at 75.2 m. The second borehole slightly diverged from the first one. For this reason, from 65.6 to 71.1 m. parallels cores are available. The stratigraphic analysis carried out both in the field and in the cold lab confirmed the good overlapping of these sections. The first core has been processed down to 71.1 m. and the second one from 68.6 m. down to the bedrock (75.2 m.). For about 2.8 m. we fully processed the sections obtaining overlapping samples for all the different kind of analysis. For the remaining 5 sections (about 3.5 m), duplicate samples have been prepared only for melter analysis. The availability of duplicate parallel sections is extremely important to carry out reproducibility tests, which are normally impossible to do.
About 125 samples have been analyzed for stable isotopes (δD, $\delta^{18}O$) and about 15 for ^{3}H.

Both the Coltrondo and Danta di Cadore peat cores have been fully processed, providing sub-samples for physical, biological and chemical measurements.

The entire cores were first frozen at -18°C, immediately after collection and then cut in cold conditions into 2 sub-cores. One sub-core was preserved for continuous X-Ray Fluorescence (XRF) core scanner analysis, while the other was used for chemical and physical measurements. This second sub-core was cut into 1-cm slices and each slice was then divided into 6 squares to obtain several subsamples. The outside edges were discarded to ensure that only the uncontaminated part of each sample was used for analysis. The subsamples were taken from the same position in each slice. The table, guides and saw were carefully cleaned with acetone and methanol in order to remove any potential contamination that could interfere with the subsequent measurements. The cutting resolution was fixed at 10mm and about 700 and 250 subsamples have been prepared for the Danta di Cadore and Coltrondo bogs, respectively.

For both peat bog cores the age-depth relationship is based on Accelerator Mass Spectrometry (AMS) ^{14}C, and ^{210}Pb and ^{137}Cs measurements. By now, information about age-dating is available only for Danta di Cadore peat bog core. For radiocarbon determinations, samples were collected from the core at different depths, cleaned with Milli-Q water and dried at 105°C and then submitted for radiocarbon analysis to the Chrono Centre, Queens University of Belfast. Radiocarbon ages were calibrated as calendar years before present (cal BP) with the CALIB 6.0 software. The results are presented with 95% confidence intervals and 2σ-ranges. In addition to the ^{14}C age dating, the upper 40 cm layers of the bog core were dated using ^{210}Pb and ^{137}Cs measurements. For ^{210}Pb and ^{137}Cs determination, dried peat samples were analyzed by direct gamma assay in the Liverpool University Environmental Radioactivity Laboratory using OrtecHPGe GWL series well-type coaxial low background intrinsic germanium detectors.

Peat components were measured quantitatively by loss-on-ignition (LOI). After recording the peat wet weight, samples were dried at 105°C overnight and the dry mass was weighed using a KERN balance Alt 220-4-NM (1 mg resolution). The ash content was measured after placing dried samples for 5 hours in a muffle furnace at 550°C. To be sure that all organic material was oxidized, we tested selected samples at 900°C. The difference between the two ash temperatures was less than 0.2% in the final weight.

Each 1-cm slice was sealed in a polyethylene bag and then squeezed with constant pressure to extract the pore water following the protocol defined by Givelet et al. (2004). Subsamples of this pore water were immediately analyzed for pH and electrical conductivity (EC) using a CRISON multiprobe MM 40+. Pore water samples were centrifuged for 10 minutes at 3000 rpm using a Rotina 38, HETTICH. Once centrifuged, pore water samples were analyzed at the University of Venice using an AGILENT 7500cx collision/reaction cell inductively coupled plasma mass spectrometer (CRC-ICP-MS) equipped with a CETAC ASX-520 auto-sampler to determine the concentrations of 36 major and trace element.

Special Project P5:

During the first months of activity, a detailed check of the available literature from several national and international database was performed, dealing with lakes located not only in the Alps, but also in the whole Italian territory. This preliminary survey allowed to identify 49 sites where lacustrine sediment cores are available, located as follows:

27 lakes in North Italy; 14 in central Italy; 8 in south Italy and islands. A total of 123 peer-review papers concerning these sites have been selected, which describe the Holocene period in different time lapses.

The research activities carried out in the first seven months allowed to recover literature data (bibliography containing useful information for paleoclimatic studies) relating to the Holocene time interval, from which paleoclimatic proxy data, giving information about the last 2000 years, were extracted. As for paleo-limnological proxies, the focus was on:

- Loss-on-ignition (LOI) to estimate the organic content of lake sediments.
- Magnetic susceptibility to infer variations in glacier activity.
- Diatom, focusing our attention on two key questions: (a) which physical aspects of climate (e.g. temperature, radiation) are diatoms responding to and (b) which season dominates the climatic response.
- Spectrophotometric and chromatographic analyses of fossil algal and bacterial pigments as a mean of assessing limnological responses to changing climate and as a basis for reconstructing past temperatures.
- Pollen to infer vegetational changes, that are directly correlated to climate oscillations.

3.2 Applications; technological and computational aspects

Special Project P6:

The extraction of glacio-chemical information from ice cores is a challenge exacerbated by the very low concentrations of some impurities, thereby demanding rigorous control of external contamination sources and very sensitive analytical techniques. High resolution chemical sampling profiles are normally required, especially for glaciers with low annual snow accumulation of fresh snow. The development of continuous ice-core melting systems over the last few years has considerably increased the temporal resolution with respect to the extremely labor-intensive and time-consuming traditional chiseling procedure.

During this first part of the project a new melting system has been planned, developed and then realized in the University Ca' Foscari workshop.

The melting system is hosted in a -20°C vertical freezer and consists of a melting head made of high purity (>99.9%) anodized Aluminum. The temperature of the melting head is regulated by a digital thermostat, normally fixed at 30°C, using an electrical heater coupled with a thermocouple. Aluminum is used because of its good thermal conductivity and it's availability in a pure form. The melting head consisted of two sections, the inner comprising a square of 22 mm diameter, corresponding to about 48% of the total 32mmx32mm cross-section (Fig. 2). Melt head case and core holders have been made.

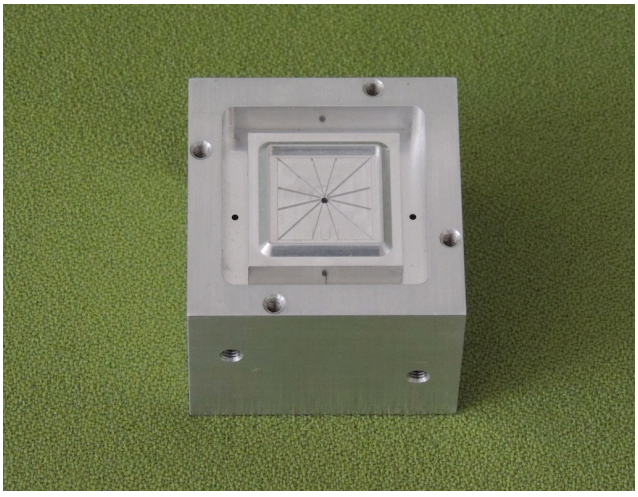

Fig. 2 Al-made melt head

Special Project P5:

As preliminary activity, archives and scientific literature have been used to extract all the necessary metadata for the characterization of the sites in accordance with the guideline of the Web-GIS dedicated to the archive of sediment cores developed under the NextData WP 2.3. They will be uploaded to build up the archive of lakes sediment cores.

3.3 Training activities

Special Project P6:

Training for isotopic measurements ($\delta^{13}C$ and $\delta^{15}N$) of the Danta di Cadore peat samples, Universtity of Alberta, Edmonton (CA), 14 March – 20 June, 2013

School of Soil and Biodiversity, University of Alberta, Lac la Biche (CA), 30 April – 3 May 2013

Training for pollen identifications and analysis of Coltrondo peat samples, University of Innsbruck, Innsbruck, 11-25, November, 2013

3.4 Dissemination

Special Project P6:

Seminar at the University of Alberta, Department of Renewable Resources: *Cross calibration between XRF-CS and CRC-ICP-QMS for high spatial resolution analysis of ombrotrophic peat bogs*, Edmonton, 13 May, 2013

Seminar at the University of Innsbruck, Department of Palynology & Archaeobotany: *Reconstruction of Holocene climate dynamics in the Dolomites from a peat bog core: the first multi-proxy study*, Innsbruck, 20 November, 2013

Italian Alpine Club, Guided tours to visit Danta di Cadore bogs Belluno, Summer, 2013

Special Project P5:

Some of the results achieved on paleodata from lakes included in the survey, have been illustrated by an oral presentation at the *XXI CONGRESSO dell'Associazione Italiana di Oceanologia e Limnologia (AIOL)* 2013: ZANNONI M., A. LAMI, S. MUSAZZI, R. TREVISAN. Ricostruzione paleolimnologica mediante l'analisi di diatomee subfossili nei sedimenti del lago Colbricon inferiore (Trentino).

A special issue "A water world at high altitude" that is the first volume of a trilogy, entitled *Climate Change in the Alps,* aimed at the general public, teachers and high school students.

3.5 Participation in conferences, workshops, meetings

Special Project P6:

Conferences

MUW 2103 - Mountains under watch (poster: "The first continuous last Late-Glacial – Holocene peat bog record from the Dolomites (NE Italian Alps)". Bard, Aosta, 19-22 February, 2013

Ortles meeting, Bolzano, 10, September, 2013

Opening ceremony – doctoral year 2013/2014 – poster "Holocene climate and environmental variations in the Dolomites area through the pollen analysis of the Coltrondo peat bog core (Comelico, BL)" Venice, 10 October, 2013

Workshops

University of Alberta - Soil degradation and land reclamation (poster: "Climatic reconstruction and environmental changes recorded in peat bogs in the NE Italian Alps during the Holocene"). Edmonton (CA), 3, April, 2013

Special Project P5:

High Summit*: International Conference on Mountains and Climate Change*, Lecco (Italy), 23-25 October 2013.Organiser: Comitato Ev-K2-CNR.

Mountains Under Watch - Observing Climate Change in the Alps. Forte di Bard, Aosta Valley (Italy), 20-21 February 2013.

Meeting of scientific information for policy-makers: *The changing mountains of Europe: Water resources and ecosystems at risk*. European Parliament (Belgium), 15 October 2013. Organiser: European Climate Research Alliance (ECRA).

SHARE Stelvio press conference: *Ice, Water and Air - new data to know the impacts of Climate Change on the "Cold Heart" of the Central Alps (Lombardy).* University of Milan, (Italy), 11 December 2013.

XXI Congresso dell'Associazione Italiana di Oceanologia e Limnologia A.I.O.L. Lignano Sabbiadoro (UD), 23-26 September 2013.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

Special Project P6:

Ortles ice core

- Processing of the core. Preparing samples for discrete analyses (pollens, therpens and stable isotopes) and for continuous flow analyses (CFA).
- Melting system: has been planned and developed at the Ca' Foscari University. workshop. The melting head made of high purity (>99.9%) anodized Aluminum has been realized.

Danta di Cadore peatbog core

- Processing of the entire core.
- Radiocarbon dating and radiometric measurements (^{210}Pb e ^{137}Cs).
- Physical analyses of the entire core (water content, organic matter and ash content, pH e EC).
- Chemical analyses of the pore water samples.

Coltrondo peatbog core

- Processing of the entire core.
- Physical analyses of the entire core (water content, organic matter and ash content, pH e EC).

Special Project P5:

Data and metadata from 49 sampling sites located in the whole Italian territory were extracted and the related literature was examined. By now, together with the coordinators of WP2.1. WP2.3 and WP2.4, we are considering how to adapt the scheme already defined for publishing marine paleodata, in order to upload also the data from lake sediments archives in the NextData geo-database.

4.2 Publications

POTO L., GABRIELI J., CROWHURST S.J., APPLEBY P.G., FERRETTI P., SURIAN N., COZZI G., ZACCONE C., TURETTA C., PINI R., KEHRWALD N., BARBANTE, C. 2013: The first continuous Late Glacial - Holocene peat bog multi-proxy record from the Dolomites (NE Italian Alps). *Quaternary international*, 306: 71-79.

4.3 Availability of data and model outputs (format, type of library, etc)

The collected data are internally available in spreadsheet format (excel)

4.4 Completed deliverables

No Deliverable scheduled in this activity period.

5. Comment on differences between expected activities/results/Deliverables and those which have been actually performed.

The planned roadmap has been followed without delays or substantial problems. For P5, it was decided to extend the data collection to the whole Italian territory.

6. Expected activities for the following reference period

Special Project P6:

Ortles ice core

- Development and testing of the melting system; connection and calibration of all the instruments.
- Decontamination of the Ortles ice core through melting system.

- High-resolution black carbon profile.
- High-resolution trace elements profiles.
- High-resolution electrical conductivity profile.
- Collection of discrete samples for further discontinuous analyses.
- Validation of experimental datasets.
- Continuation of stable isotopes (δD, $\delta^{18}O$) analysis.
- Development of a preliminary depth/age model.

Danta di Cadore and Coltrondo peat bog cores

- Continuation of pollen measurements in both cores.
- Trace elements profiles in the Coltrondo bog.
- Dating of the Danta di Cadore and Coltrondo peat bogs and development of an age/depth model for each core.
- Collection of the deep lake sediments at the bottom of the peat core.
- Installation of a meteorological station on the Danta di Cadore bog and acquisition of meteorological data.
- Monthly sampling of surface waters and precipitations in the Danta di Cadore.

Special Project P5:

Based on the results from the previous year, the activity will focus on the site selection and coring of one or two appropriate pro-glacial and non-glacial lakes, litho-stratigraphic and bio-stratigraphic analyses, and radiometric dating, in order to provide time series data (dry weight, water and organic content, pigments, diatoms, magnetic susceptibility) for a detailed reconstruction of changes in trophic state, biodiversity and ecosystems in mountain areas and in other strategic regions, with the final aim to compare these reconstruction with the output generated by the modelling activity of NextData.

During the second year we expect to upload the geo and biostratigraphic data and metadata for the new sites in NextData archive, and to adapt them to the format already used to catalogue marine sediment data on GeoNetwork. At the same time we will also start to populate the NextData database with the available data for the different records.

Moreover, we will further develop contacts with several research institutions, in order to gather information (if available) on lacustrine sediments cores taken in the Italian territory that currently are not available in the scientific literature / international databases. One of them is the Varves Working Group (VWG), within the framework of the 2K-Network (PAGES), involved in a varve-sediment database creation, to verify the availability of additional Italian sites with numerical proxies (biotic and abiotic) useful to compare the response of different sector of Italian territory (strongly connected with the Mediterranean sea or Alpine glaciers) to climatic fluctuations.

Dissemination task will be continued with the participation in scientific conferences and workshops and other events dedicated to the wider public.