

Final project report

Project ID: 2002/ 5.01
Title: Paleo-climate and paleo-environment from chemical, physical and isotopic stratigraphy of ice core

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Duration: 2 years
Assigned funding: € 162.491,00

Activities and results

Activity in Antarctica

2002/03

Dome C: processing and sub-sampling of EDC99 ice core in the depth range 2162 - 3190 m). DEP, ECM, CFA and FIC measurements were carried out with continuous or semi-continuous methods. Discontinuous samples were sent to the European laboratories. Size-segregated aerosol, superficial snow and hoar samples were collected in order to study the atmosphere-snow interactions and post-depositional processes.

2003/04

Dome C: explorative tests were carried out in order to find the best re-freezing liquid able to recover the deeper part of the EDC99 ice core.

Kohnen Station: scientific activity in supporting the drilling, logging and sub-sampling of the EPICA-DML ice core (1565 - 2566 m depth range).

Talos Dome: snow and firn samples were collected in 5 snow-pits located in the centre and around the site of the future Talos Dome deep coring (TALDICE project). Such activity was devoted to study the site spatial variability and the seasonal pattern of climatic and environmental markers in the snow.

Activity in Europe

AWI – Bremerhaven, Germany.

On June 2002, about 340 m (113 - 449 m) of the EDML ice core were processed for sub-sampling and on-field analysis. Continuously melted ice core samples were analysed by CFA and FIC methods to obtain chemical stratigraphies. Sub-samples were obtained and sent to the European laboratories. Similar activity was carried out during 4 work sessions in the 2004. Sub-sampling (42,000 samples), CFA and FIC measurements were performed on about 2100 m (450 - 2564 m) of the EDML and on the last 50 m (3139 - 3190 m) of the EDC99 ice cores.

Italian Laboratories

EDC99 ice core - During 2002, 2003 and 2004, scientific activity was focused on obtaining physical, chemical and isotopic high-resolution stratigraphies. Isotopic (dD and $d^{18}O$), chemical markers (ions and metals), volcanic and dust profiles were obtained in the depth range 770 - 2160 m. Detailed chemical analysis was carried out on discontinuous samples in the 1390-2160 m range. On selected samples, Pb isotopic ratios were measured in order to identify past aerosol sources. Trace elements, such as Ir and Pt, were used to evaluate the dust cosmic flux. Principal components in insoluble particles were measured by PIXE elemental analysis. Selected ice samples were analysed by Coulter Counter for the determination of concentration and size-distribution of insoluble particles of continental dust trapped in the snow. The Nd/Sr isotopic ratio was used to identify potential source areas during glacial periods. Thirteen tephra layers in the first 2200 m EDC ice core were characterised by granulometric, lithologic, micro-structural and geo-chemical analysis Results were also used for dating purposes.

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From dD and $d^{18}O$ measurements, the deuterium excess (d) was evaluated in order to reconstruct the SST in the moisture source areas for Antarctic precipitations.

EDML ice core – During 2003 and 2004, measurements of physical, chemical and isotopic composition of the ice core samples (100 - 450 m) were performed following the same protocol used for EDC analysis.

Chemical analyses were carried out on size-segregated aerosol, firn, snow and hoar samples collected during the summer field activity at Dome C and Talos Dome. High-resolution snow-pit samples were analysed to obtain preliminary information on glaciological and depositional features at Talos Dome.

Methodological approaches and main results were shown in the papers and in the meeting proceedings here reported.

Products

A – papers in scientific magazines

2002

1. Barnes P., P., E. Wolff, R. Mulvaney, R. Udisti, E. Castellano, R. Rothlisberger, J.P. Steffensen. The effect of density on electrical conductivity of chemically laden polar ice. *J. Geophys. Res.*, 2002, 107 (B2), 10.1029/2000JB000080.
2. Benassai S., E. Castellano, O. Largiuni, A. Migliori, M. Severi, R. Udisti. Variabilità del sito a Dome C (Antartide) dal confronto di stratigrafie chimiche. In: "La contaminazione chimica in Antartide", P. Cescon ed., Viareggio (Italy), 2002, 118-131.
3. Delmonte B., Petit J.R., Maggi V., Glacial to Holocene implications of the new 27,000 year dust record from the EPICA Dome C (East Antarctica) ice core, *Climate Dynamics*, 18(8), 647–660, 2002. DOI: 10.1007/s00382-001-0193-9.
4. Delmonte B., Petit J.R., Maggi V. LGM-Holocene changes and Holocene millennial-scale oscillations of dust particles in the EPICA-Dome C ice core (East Antarctica). *Annals of Glaciology*, 2002, 35, 306-312.
5. Epica Dome C 2001-02 science and drilling teams (fra i quali: Castellano E., Severi, M., Migliori A., Delmonte, B., Marinoni, A.) Extending the Ice Core Record beyond half a million years, *Eos Trans.* 83, 509-517, 2002.
6. Fattori I., S. Becagli, E. Castellano, A. Migliori, R. Traversi, R. Udisti. Studio delle relazioni tra precipitazioni nevose ed aerosol a Baia Terranova e Dome C (Antartide). In: "La contaminazione chimica in Antartide", P. Cescon ed., Viareggio (Italy), 2002, 101-117.
7. Largiuni O., S. Becagli, M. Frezzotti, M. Severi, R. Traversi, R. Udisti. H_2O_2 and HCHO distribution in surface snow and firn from coastal areas to Dome C (Antarctica). In: "Italian Research on Antarctic Atmosphere" - M. Colacino ed., SIF - Bologna, 2002, 80, 253-262.
8. Littot G.C., R. Mulvaney, R. Rothlisberger, R. Udisti, E. Wolff, E. Castellano, M. De Angelis, M. Hansson, S. Sommer, J.P. Steffensen. Comparison of analytical methods used for measuring major ions in the EPICA-Dome C (Antarctica) ice core. *Ann. Glaciol.*, 2002, 35, 299-305.
9. Migliori A., S. Becagli, S. Benassai, I. Fattori, R. Traversi, R. Udisti. Comparison between aerosol chemical composition at Terra Nova Bay and Dome C (Antarctica): preliminary results. In: "Italian Research on Antarctic Atmosphere" - M. Colacino ed., SIF - Bologna, 2002, 80, 239-252.
10. Traversi R., S. Becagli, E. Castellano, A. Migliori, M. Severi, R. Udisti. High-resolution Fast Ion Chromatography (FIC) measurements of chloride, nitrate and sulphate along the EPICA-Dome C ice core. *Ann. Glaciol.*, 2002, 35, 291-298.

2003

1. Barnes P.R.F., E.W. Wolff, H.M. Mader, R. Udisti, E. Castellano, R. Röthlisberger. The evolution of chemical peak shapes in the Dome C, Antarctica, ice core. *J. Geophys. Res.*, 2003, 108 (D3), 4126, doi:10.1029/2002JD002538, 2003.
2. Castellano E., S. Becagli, R. Traversi, S. Benassai, I. Fattori, R. Udisti. The 45000-year palaeovolcanic record in the EDC96 ice core (EPICA). *Terra Antarctica Reports*, 2003, No. 8, 77-82
3. Delmonte B., Basile-Doelsch I., Michard A., Petit J.R., Maggi V., Gemmiti B., Revel M. Sr-Nd Signature of potential source areas for dust in east Antarctica: preliminary results. *Terra Antarctica Reports*, 2003, 8, 83-85.
4. Delmonte B., Basile-Doelsch I., Petit J.R., Michard A., Revel M., Maggi V., Gemmiti B. Refining the isotopic (Sr-Nd) signature of potential source areas for glacial dust in East Antarctica, *Journal de Physique*, IV, 2003, 107, 365-369, DOI: 10.1051/JP4:20030317.
5. Gabrielli P., Barbante C., Planchon F.A.M., Ferrari C., Delmonte B., Boutron C.F. Changes in the occurrence of heavy metals in polar ice during the last climatic cycles, with special emphasis on the possible link between cosmic dust accretion rate and the 100 Kyr cycle. *Journal de Physique*, IV, 2003, 107, 499-503. DOI: 10.1051/JP4:20030350.
6. Ghermandi G., R. Cecchi, M. Capotosto, F. Marino. Elemental composition determined by PIXE analysis of the insoluble atmospheric aerosol particles in EPICA-Dome C ice core samples representing the last 27000 years. *GRL*, 2003, Vol.30, NO.22, 2176-2180.

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- Marino F., G. Ghermandi, V. Maggi. Elemental characterization of insoluble atmospheric aerosol in EPICA ice core using PIXE analyses. *Terra Antartica Reports*, 2003, 8, 95-100.
- Marino F., V. Maggi, G. Ghermandi, D. Ceccato and R. Cecchi. The PIXE (Proton-Induced X-ray Emission) analytical technique to detect insoluble atmospheric microparticles achieved in the EPICA-Dome C ice core (Antarctica): paleoclimatic implications. *Frascati Physic Series Vol. XXXII*, 2003, 189-212.
- Rothlisberger R., R. Mulvaney, E. Wolff, M.A. Hutterli, M. Bigler, M de Angelis, M.E. Hansson, J.P. Steffensen, R. Udisti. Limited dechlorination of sea-salt aerosol during the last glacial period: Evidence from the European Project for Ice Coring in Antarctica (EPICA) Dome C ice core. *J. Geophys.Res.*, 2003, 108(D16),4526, doi:10.1029/2003JD003604.
- Stenni B., J. Jouzel, V. Masson-Delmotte, R. Rothlisberger, E. Castellano, O. Cattani, S. Falourd, S.J. Johnsen, A. Longinelli, J.P. Sachs, E. Selmo, R. Souchez, J.P. Steffensen, R. Udisti. A late-glacial high resolution site and source temperature record derived from the EPICA Dome C isotope records (East Antarctica). *Earth Planet. Sci. Lett.*, 2003, 217, 183-195.
- Traversi R., S. Becagli, S. Benassai, E. Castellano, I. Fattori, R. Udisti. Sea-salt component behaviour in the last glacial/interglacial transition from the analysis of the EDC96 ice core. *Terra Antartica Reports*, 2003, No. 8, 101-105
- Truzzi C., L. Lambertucci, A. Annibaldi, G. Gambini, S. Becagli, R. Traversi, R. Udisti, G. Scarponi. Identification of sources of antarctic aerosol in Victoria Land by means of Principal Component Analysis of chemical data. *Terra Antartica Reports*, 2003, No. 8, 37-42.
- Udisti R., S. Becagli, E. Castellano, A. Migliori, J. R. Petit, J. Schwander, M. Severi, R. Traversi. Preliminary synchronization of EPICA-Dome C and Vostok ice cores by comparing volcanic signatures. *Terra Antartica Reports*, 2003, No. 8, 107-111

2004

- Becagli S., M. Proposito, S. Benassai, O. Flora, L. Genoni, R. Gragnani, O. Largiuni, S.L. Pili, M. Severi, B. Stenni, R. Traversi, R. Udisti, M. Frezzotti. Chemical and isotopic snow variability in East Antarctica along the 2001/02 ITASE traverse. *Ann. Glaciol.*, 39, 2004, 473-482.
- Becagli S., S. Benassai, E. Castellano, O. Largiuni, A. Migliori, R. Traversi, O. Flora, R. Udisti. Chemical characterization of the last 250 years of snow deposition at Talos Dome (East Antarctica). *Intern. J. Environ. Anal. Chem.*, 2004, 84(6-7), 523-536.
- Castellano E., S. Becagli, J. Jouzel, A. Migliori, M. Severi, J.P. Steffensen, R. Traversi, R. Udisti. Volcanic eruption frequency over the last 45 ky as recorded in EPICA-Dome C ice core (East Antarctica) and its relationship with climatic changes. *Global and Planetary Change*, 2004, 42(1-4), 195-205.
- Delmonte B., Basile-Doelsch I., Petit J.R., Maggi V., Revel M., Michard A., Jagoutz E., Grousset F. Comparing the Epica and Vostok dust records during the last 220,000 years: stratigraphical correlation and provenance in glacial periods. *Earth Science Reviews*, 2004, 66, 63-87. doi:10.1016/j.earscirev.2003.10.004
- Delmonte B., Petit J.R., Andersen K.K., Basile-Doelsch I., Maggi V. Lipenkov, V. Dust size evidence for opposite regional atmospheric circulation changes over East Antarctica during the last climatic transition, *Climate Dynamics*, 2004, 23: 427-438. DOI: 10.1007/s00382-004-0450-9.
- Delmonte B., Petit J.R., Basile-Doelsch I., Lipenkov V., Maggi V. First characterization and dating of East Antarctic bedrock inclusions from subglacial Lake Vostok accreted ice, *Environmental Chemistry*, 2004, 1, 90-94. DOI:10.1071/EN04029.
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- Fattori I., S. Bellandi, S. Benassai, M. Innocenti, A. Mannini, R. Udisti. Ion balances of size resolved aerosol samples from Terra Nova Bay and Dome C (Antarctica). In: "Italian Research on Antarctic Atmosphere" - M. Colacino ed., SIF - Bologna, 2004, 89, 101-115.
- Hong S., C. Boutron, P. Gabrielli, C. Barbante, C. Ferrari, J.R. Petit, K. Lee, V. Lipenkov. Past natural changes in Cu, Zn and Cd in Vostok Antarctic ice dated back to the beginning of the next to last ice age. *Geophys. Res. Lett.*, 2004, 31, doi:10.1029/2004GL021075.
- Innocenti M., S. Becagli, S. Bellandi, I. Fattori, A. Mannini, M. Severi, R. Udisti. Surface-distribution pattern of atmospheric aerosol particles collected in coastal and inner Antarctic sites by Atomic Force Microscopy measurements. In: "Italian Research on Antarctic Atmosphere" - M. Colacino ed., SIF - Bologna, 2004, 89, 87-99.
- Jitaru P., C. Ferrari, A. Dommergue, P.A. Gauchard, C. Boutron, P. Gabrielli, C. Barbante, F. Adams. Speciation analysis of mercury in the polar environment by multi-capillary gas chromatography inductively coupled plasma time-of-flight mass spectrometry. *Material and Geoenvironment*, 2004, 51, 1947-1950.
- Largiuni O., E. Castellano, A. Migliori, R. Traversi, G. Piccardi, R. Udisti. Preliminary study of HCHO spatial and temporal distribution from coastal to plateau areas in Antarctica. *Intern. J. Environ. Anal. Chem.*, 2004, 84(6-7), 537-549.
- Marino F., Maggi V., Delmonte B., Ghermandi G., Petit J.R. Elemental composition (Si, Fe, Ti) of atmospheric dust over the last 220 kyr from the EPICA ice core (Dome C, Antarctica). *Ann. Glaciol.*, 2004, 39, 110-118.

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14. Masson-Delmotte V., Stenni B. & Jouzel J., Common millennial-scale variability of Antarctic and southern ocean temperatures during the past 5000 years reconstructed from the EPICA Dome C ice core. *The Holocene*, 2004, 14 (2), 145-151.
15. Traversi R., C. Barbante, V. Gaspari, I. Fattori, O. Largiuni, L. Magaldi, R. Udisti. Aluminium and iron record for the last 28 kyrs derived from the Antarctic EDC96 ice core using new CFA methods. *Ann. Glaciol.*, 39, 2004, 300-306.
16. Traversi R., S. Becagli, E. Castellano, O. Largiuni, A. Migliori, M. Severi, M. Frezzotti, R. Udisti. Spatial and temporal distribution of environmental markers from coastal to plateau areas in Antarctica by firn core analysis. *Intern. J. Environ. Anal. Chem.*, 2004, 84(6-7), 523-536.
17. Udisti R., S. Becagli, E. Castellano, B. Delmonte, J. Jouzel, J-R Petit, J. Schwander, B. Stenni and E. Wolff. Stratigraphic correlations between the European Project for Ice Coring in Antarctica (EPICA) Dome C and Vostok ice cores showing the relative variation of snow accumulation over the past 45 kyr. *J. Geophys. Res.*, 2004, 109, D08101, doi:10.1029/2003JD004180.
18. Udisti R., S. Becagli, S. Benassai, E. Castellano, I. Fattori, M. Innocenti, A. Migliori, R. Traversi. Atmosphere-snow interaction by a comparison between aerosol and uppermost snow layers composition at Dome C (East Antarctica). *Ann. Glaciol.*, 39, 2004, 53-61.
19. Udisti R., S. Becagli, S. Benassai, M. De Angelis, M.E. Hansson, J. Jouzel, J. Schwander, J.P. Steffensen, R. Traversi, E. Wolff. Sensitivity of chemical species to climate changes in the last 45 ka as revealed by high resolution Dome C (Antarctica) ice core analysis. *Ann. Glaciol.*, 39, 2004, 457-466.

2005 on (sono qui riportati i soli contributi che sono relativi alla sola attività svolta nell'ambito del progetto biennale 2002-2003)

1. Annibaldi, A.; Truzzi, C.; Illuminati, S.; Scarponi, G. Soluble/insoluble fractionation of Cd, Pb and Cu in Antarctic snow by square wave anodic stripping voltammetry. In preparazione.
2. Narcisi B., Petit J.R., Delmonte B., Basile-Doelsch I., Maggi V.: Characteristics and sources of tephra layers in the EPICA-Dome C ice record (East Antarctica): implications for past atmospheric circulation and ice core stratigraphic correlations. *Earth and Planetary Science Letters*, 2005, 239, 253-265.
3. Narcisi B., Petit J.R., Delmonte B., TIEPOLO M., Basile-Doelsch I., Maggi V. (sottoposto gennaio 2006): Geochemical features of tephra layers in the EPICA-Dome C climatic record (East Antarctica). *Terra Antarctica Reports*, 14, in stampa.
4. Truzzi, C.; Annibaldi, A.; Illuminati, S.; Becagli, S.; Traversi, R.; Udisti, R.; and Scarponi, G. Sources of Antarctic aerosol in Victoria Land by means of principal component analysis (Varimax rotation) applied to snow chemical data. *Terra Antarctica Reports*, 2008, 14 bozze di stampa
5. Truzzi, C.; Lambertucci, L.; Illuminati, S.; Annibaldi, A.; and Scarponi, G. Direct gravimetric measurements of the mass of the Antarctic aerosol collected by high volume sampler: PM10 summer seasonal variation at Terra Nova Bay. *Ann. Chim.*, 2005, 95, 867-876.

B – book chapters

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C - proceedings of international conferences

2002

1. Castellano E., S. Becagli, A. Migliori, R. Traversi, M. Frezzotti, R. Gragnani, M. Proposito, R. Udisti. Paleo-volcanism recorded in semi-plateau and plateau areas in East Antarctica. *European Geophysical Society - XXVII General Assembly - Nice (France)*, 21-26 April 2002. *Geophys. Res. Abstr.*, 4, 2002, EGS02-A-06279.
2. Udisti R. New interpretation of Dome C/Vostok accumulation ratio change in the last 45000 years. *EPICA Meeting of Science Sub-groups. Potsdam (Germany)*, 16-17 Sept. 2002.
3. Udisti R. Comparing old and new data in the overlapping between EDC96 and EDC99 ice cores. *EPICA Meeting of Science Sub-groups. Potsdam (Germany)*, 16-17 Sept. 2002.
4. Udisti R. Volcanic peak identification, flux and frequency calculation in the last 45000 years. *EPICA Meeting of Science Sub-groups. Potsdam (Germany)*, 16-17 Sept. 2002.
5. Udisti R. New very high resolution sulphate method possibly with some preliminary sulphate profiles. *EPICA Meeting of Science Sub-groups. Potsdam (Germany)*, 16-17 Sept. 2002.
6. Frezzotti M., M. Pourchet, S. Urbini, S. Gandolfi, O. Flora, M. Gay, M. Proposito, M. Severi, M. Fily, R. Gragnani, R. Udisti. Impact of wind scouring on surface mass balance and ice core interpretation. *First Joint EPICA/ITASE Workshop - Potsdam (Germany)*, 18-20 Sept. 2002.
7. Severi M., S. Benassai, A. Migliori, E. Castellano, S. Becagli, R. Traversi, R. Udisti. Improved high resolution FIC method for sulphate and preliminary results from DML ice core analysis. *First Joint EPICA/ITASE Workshop - Potsdam (Germany)*, 18-20 Sept. 2002.
8. Becagli S., R. Traversi, E. Castellano, R. Gragnani, M. Proposito, B. Stenni, O. Flora, M. Frezzotti, R. Udisti. Preliminary evidences of sulphur-compounds as a proxy-marker of SOI and sea-ice from Talos Dome firn core. *First Joint EPICA/ITASE Workshop - Potsdam (Germany)*, 18-20 Sept. 2002.
9. Udisti R, J. Jouzel, J.R. Petit, J. Schwander, B. Stenni, S. Becagli, E. Castellano. Variation of the accumulation ratio between Dome C and Vostok over the last 45000 years and its climatic implications. *First Joint EPICA/ITASE Workshop - Potsdam (Germany)*, 18-20 Sept. 2002.

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10. Antarctic Italian Team. Talos Dome: a future site for coastal deep drilling – geophysical and geochemical surveys. First Joint EPICA/ITASE Workshop - Potsdam (Germany), 18-20 Sept. 2002.
11. Castellano E., A. Migliori, M. Severi, S. Becagli, R. Traversi, R. Udisti. High-resolution FIC measurements of chloride, nitrate and sulphate in the whole last glacial/interglacial cycle. First Joint EPICA/ITASE Workshop - Potsdam (Germany), 18-20 Sept. 2002.
12. Castellano E., S. Becagli, A. Migliori, M. Severi, R. Traversi, R. Udisti. EDC96 ice core volcanic stratigraphy and frequency distribution of volcanic fluxes in the last 45000 years. First Joint EPICA/ITASE Workshop - Potsdam (Germany), 18-20 Sept. 2002.
13. Stenni B., Masson-Delmotte V., Longinelli A., Selmo E., Jouzel J., Cattani O., Falourd S., Rothlisberger R. & Johnsen S.: A 45 ka record of Antarctic and mixture source sea surface temperature variations from EPICA Dome C ice core. First Joint EPICA/ITASE Workshop - Potsdam (Germany), 18-20 Sept. 2002.
14. Masson-Delmotte V., Stenni B. & Jouzel J.: The Holocene variability of deuterium and excess at Dome C. First Joint EPICA/ITASE Workshop - Potsdam (Germany), 18-20 Sept. 2002.
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16. Delmonte B., Basile-Doelsch I., Michard A., Petit J.R., Maggi V., Gemmiti B., Revel M., Sr-Nd Signature of potential source areas for dust in east Antarctica: preliminary results. *Geochimica Cosmochem. Acta*, Goldschmidt Conference Abstract, 2002.
17. Rothlisberger R., N.A. Hutterli, R. Mulvaney, E.W. Wolff, M. Bigler, M. de Angelis, M.E. Hansson, J.P. Steffensen, R. Udisti. Limited dechlorination of sea-salt aerosols during the last glacial period. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 03262, 2003.
18. Stenni B., V. Masson-Delmotte, E. Castellano, S. Johnsen, J. Jouzel, A. Longinelli, R. Rothlisberger, E. Selmo, R. Udisti. A 45 ka deuterium excess record at Dome Concordia, East Antarctica. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 05469, 2003.
19. Jouzel J., Cattani O., Cherrier S., Dreyfus G., Falourd S., Masson V., Stenni B., Longinelli A., Johnsen S.J., Parrenin F., Souchez R., Schwander J., Steffensen J.P., Wolff E., 2003. The new EPICA Dome C deuterium temperature record. *Geophysical Research Abstracts*, EGS-AGU-EUG Joint Assembly, Vol. 5, 08626.
20. Masson-Delmotte V., Jouzel J., Stenni B., 2003. Holocene site and source temperature variations reconstructed from EPICA stable isotopes. *Geophysical Research Abstracts*, EGS-AGU-EUG Joint Assembly, Vol. 5, 10532.
21. Migliori A., S. Becagli, S. Benassai, E. Castellano, M. Severi, R. Traversi, R. Udisti. Chloride, nitrate and sulphate high resolution records for the last two glacial-interglacial cycles from EDC ice core. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 07199, 2003.
22. Severi M., S. Becagli, S. Benassai, E. Castellano, A. Migliori, R. Udisti. Sulphate profile in EPICA-DML ice core (Kohnen Station – East Antarctica) by fast ion chromatography. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 07220, 2003.
23. Udisti R, S. Becagli, S. Benassai, I. Fattori, M. Innocenti, A. Migliori, R. Traversi. Summer aerosol composition and preservation of environmental markers in the snow layers at Dome C (Antarctica). A basic step for deep-ice core interpretation. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 08511, 2003.
24. Schwander J., E.W. Wolff, F. Parrenin, J. Jouzel, J.-R. Petit, C. Ritz, B. Stauffer, R. Udisti, H. Fisher, F. Wilhelms, S. Johnsen. Timescales for the EPICA ice cores. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 09965, 2003.
25. Udisti R., C. Barbante, G. Cozzi, I. Fattori, O. Largiuni, L. Magaldi, R. Traversi. Preliminary CFA measurements of Aluminium and iron "available" fraction in EPICA-Dome C ice core (East-Antarctica). *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 10248, 2003.
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27. Castellano C., S. Becagli, S. Bellandi, A. Migliori, J. Schwander, M. Severi, J.P. Steffensen, R. Traversi, R. Udisti. Volcanic stratigraphy for the last 200 kyr as recorded in EDC96 and EDC99 EPICA-Dome C ice cores. *Geophys. Res. Abstr.*, EGS-AGU-EUG Joint Assembly, Vol. 5, 10347, 2003.
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7. Becagli S., S. Benassai, E. Castellano, M. Severi, R. Traversi, R. Udisti. Distribuzione spaziale di componenti chimici nelle deposizioni nevose del settore BTN-Dome C-DDU (Antartide). Parte I - composti dello S. X Convegno Nazionale "La contaminazione chimica in Antartide", Venezia (Italy), 10-11 giugno 2004. Conference Proceedings, pp. 205-217.
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1. Petroselli A., C. Truzzi, S. Illuminati, A. Annibaldi, and G. Scarponi. Aerosol antartico: frazionamento solubile/insolubile di metalli in tracce. 11° Conv. Naz. "La Contaminazione Chimica in Antartide", Venezia, 23-24/6/2005. Extended abstracts, pp. 87-98.
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E – thematic maps

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F – patents, prototypes and data bases

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G – exhibits, organization of conferences, editing and similar

In August 2003, the Seventh International Symposium in Antarctic Glaciology (ISAG-7) was in Milan, at the Università di Milano Bicocca. ISAG-7 coordinators were Giuseppe Orombelli, Valter Maggi and Massimo Frezzotti. The meeting hosted about 300 scientists with more than 200 oral communications and posters. More than 130 papers related to the ISAG-7 meeting were published on Annals of Glaciology (International Glaciological Society), volume 39.

H - formation (PhD thesis, research fellowships, etc.)

PhD students

- Alessio Migliori
- Mirko Severi
- Paolo Gabrielli
- Giulio Cozzi
- Margherita Capotosto
- Barbara Delmonte
- Angela Marinoni
- Paola Casati
- Alberto Deponti
- Luca Lambertucci

Grant Students

- Emiliano Castellano
- Silvia Benassai
- Vania Gaspari
- Laura Genoni
- Enrico Maria Selmo
- Maurizio Santilli
- Federica Marino

Research units

FRE-UDI

Principal Investigator: Roberto Udisti
Emiliano Castellano
Alessio Migliori
Mirko Severi
Silvia Benassai

FRE-BAR

Principal Investigator: Carlo Barbante
Paolo Gabrielli
Vania Gaspari
Giulio Cozzi

FRE-FLO

Principal Investigator: Onelio Flora
Barbara Stenni
Laura Genoni
Lorenzo Furlan

FRE-GHE

Principal Investigator: Grazia Ghermandi
Rodolfo Cecchi
Sergio Teggi
Margherita Capotosto

FRE-LON

Principal Investigator: Antonio Longinelli
Paola Iacumin
Enrico Maria Selmo

FRE-MAG

Principal Investigator: Valter Maggi
Giuseppe Orombelli
Marco Filipazzi
Barbara Delmonte
Angela Marinoni
Paola Casati
Alberto Deponti
Maurizio Santilli
Federica Marino

FRE-NAR

Principal Investigator: Biancamaria Narcisi

FRE-ROS

Principal Investigator: Aristide Rossi
Stefano Bellani
Andrea Scozzari
Crescenzo Festa
Antonio Caprai
Giovanni Cavagnero
Marco Zangirolami

FRE-SCA

Principal Investigator: Giuseppe Scarponi
Cristina Truzzi
Luca Lambertucci

Date: 29 April 2008