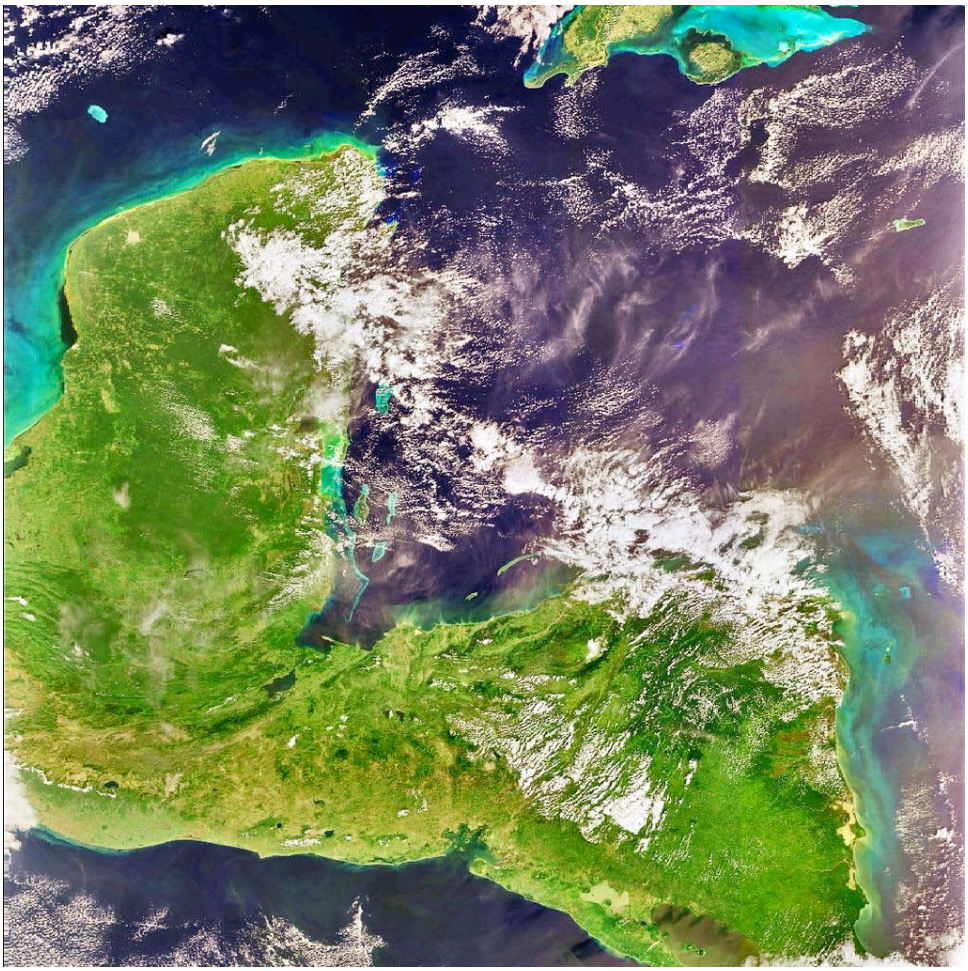
Climate Change, Natural Hazards, and Societies



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Geosciences Information For Teachers (GIFT) Workshop

Merida, Yucatan, Mexico, March 17-19, 2010

Merida 2010 GIFT Workshop

Climate Change, Natural Hazards, and Societies

Merida, Yucatan, Mexico - March 17-19, 2010

Organizing Committee

Carlo Laj

Raúl Godoy Montañez

Alfonso Larqué Saavedra

Francesco Sarti

Carlos Gay García

Jaime Urrutia Fucugauchi

Venue: Fiesta Americana Hotel, Merida, Yucatan

Merida 2010 GIFT Workshop

Climate Change, Natural Hazards, and Societies

Merida, Yucatan, Mexico - March 17-19, 2010

Dear Teacher,

Welcome to the Merida 2010 GIFT Workshop!

In the next three days you are in for a very special treat: Thanks to the European Space Agency (ESA), you will have a full presentation of the use of satellite imagery for observation of the Earth at different scales and different aspects. This presentation will be coupled with hands-on activities using material also provided by ESA, with specific attention to Mexico and Central America, so that you will be able to bring all this new information into your classrooms.

The following presentations will be given by top scientists participating in the International Alexander von Humboldt Conference, on the general theme of Climate Change, Natural Hazards, and Societies. Some of them will be given in English, some in Spanish; but in any case please do not hesitate to ask questions to the speakers. Showing your interest is the best way to thank them for addressing you in this workshop!

Before we get started, we would like to gratefully thank those who worked hard to make this workshop possible, not all of them are present here.

The Council of the European Geosciences Union (EGU) unanimously approved the idea of having a teachers' workshop in connection with the Humboldt Conference. The teachers´ workshops are part of the GIFT program on Geosciences Information for Teachers, organized by the EGU for the General Assemblies. The Merida GIFT workshop will be the first organized in cooperation with the thematic conference program of the Humboldt conferences. The GIFT Workshop has been enthusiastically received and supported by the Government of Yucatan State and the Ministry of Education. The GIFT Workshop is being supported by Education Secretary Raúl Godoy and the Yucatan Research System SIIDETEY Director Alfonso Larqué. Participation and support has also been provided by the Yucatan Research Center CICY and the National University UNAM. Francesco Sarti from ESA-ESRIN in Italy has been the overall coordinator for the space activities in the workshop, contacting people and helping to define the program. Sergio Camacho from the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean has contributed and linked the national and international activities.

Our GIFT Workshop speakers deserve our recognition for their unselfish participation, in addition to their Humboldt Conference activities. We thank Ana Belen Ruesca Orient, Jan Smit, Ana Lillian Martin, Gerald Haug, Mario Rebolledo Vieyra, Ligia Perez Cruz, Susana Alaniz Alvarez, and their insitutions for making this GIFT Workshop possible.

We also ask you to consider seriously the GIFT agreement we have asked you to endorse. The GIFT workshop is kindly sponsored by several science organizations. We would like to continue offering teachers the opportunity to attend GIFT and similar workshops, but this depends upon our being able to show our sponsors that teachers have used the new GIFT information and science didactics in their daily teaching, or as inspiration for new ways to teach science to students in their community schools.

Therefore, we first ask you to fill out as soon as possible the evaluation forms and send them to us. But also we would be very pleased that you make a presentation of your experiences at GIFT to a group of your teaching colleagues sometime after you return from EGU, and send us reports about how you have used the GIFT information in your classrooms.

We also encourage you to write reports on the GIFT workshop in the publication specifically intended for geosciences teachers.

Information on past and future GIFT workshop is available on the EGU homepage. Look at

http://gift.egu.eu

where you can find the brochure (pdf) and also the slides of the different presentations for the European GIFT workshops for the last 6 years. For 2009, we have also included web-TV presentations, which may be freely used in your classrooms.

Also, look at "The Eggs", the EGU newsletters also on the EGU homepage. Kostas Kourtidis, the Editor of the newsletter invites all teachers to look at:

http://www.the-eggs.org/

with a dedicated Education column, where you can write reports on your own work and submit them at http://www.the-eggs.org/submit/ and also use the archive at http://www.the-eggs.org/archive.php to read about other teachers' work!

We hope that you will have a productive most interesting time during the Merida GIFT Workshop!

Jaime Urrutia Fucugauchi and Carlo Laj

Acknowledgments

The Merida GIFT-2010 workshop has benefited of the generous help of :

Secretaría de Educación del Gobierno del Estado de Yucatán

The European Geosciences Union

The European Space Agency

Sistema de Investigación, Innovación y Desarrollo Tecnológico del Estado de Yucatán

The Year of Planet Earth

Merida 2010 GIFT Workshop

Climate Change, Natural Hazards, and Societies

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Program

Wednesday March 17

Welcoming Remarks by Secretary of Education of Yucatan Raul Godoy

The Earth Observation Programme of the European Space Agency (ESA)
Ana Belen Ruescas Orient
ESA-ESRIN, Frascati, Italy

Introduction to the ESA Hands-on Activities
Ana Belen Ruescas Orient
ESA-ESRIN, Frascati, Italy

ESA Hands-on Activities

Thursday March 18 morning

The Chicxulub Impact
Jan Smit
Vrije Universitaet Amsterdam
The Netherlands

Volcanoes and their Impact on Society
Ana Lillian Martin del Pozzo
UNAM, Mexico

Thursday March 18 afternoon

Climate and Environmental Change and Early Civilizations
Gerald Haug
ETH Zurich
Switzerland

Hydrology of Yucatan
Mario Rebolledo Vieyra
CICY, Merida, Mexico

Friday March 19 morning 2 talks

Past Climates
Ligia Perez Cruz
UNAM, Mexico

Promoting Geoscience Interest in Youngsters
Susana Alaniz Alvarez
UNAM, Juriquilla, Queretaro

Hands-on activities

Friday March 19 afternoon

Finish ESA hands-on Activities

Closing Remarks

Carlo Laj
Laboratoire des Sciences du Climat et de l'Environnement
Gif-sur-Yvette, France
&
Committee on Education
European Geosciences Union

Rest of the afternoon will be free for the teachers to go around the Humboldt Conference posters and presentations, question the scientists and so on.

Speakers

Ana Belén Ruescas Orient
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My remote sensing expertise has been built up over ten years of continuous work in the public university system in Spain. I have worked alongside geographers (Regional Analysis Office, University of Castellon), physicists (Global Climate Unit, University of Valencia and Department of Physics, University of La Laguna, Tenerife) and engineers (Colorado Center for Astrodynamics Research, University of Colorado at Boulder) on numerous multi-disciplinary projects related to landscape change and hydrological systems, determination of bias over sea surface temperature (SST), land surface temperature (LST) applications, etc. I have also co-operated on several projects involving surface temperature estimation by satellite and algorithm validation campaigns within the Sen2Flex and the CEFLES Projects. I am currently working in the Science Strategy, Co-ordination and Planning Office (EOP-SA) at ESA-ESRIN as a Spanish trainee, where, among other duties, I have supervised master thesis of undergraduate students, I have written scientific papers, giving conferences and attending workshops on the remote sensing field. I have also prepared specialised courses on image processing and remote sensing applications using ESA toolboxes (NEST, BEAM, PolSARpro, DORIS, KIM, etc.)

I have spent the last two years here in ESRIN learning and teaching about SAR applications in many kinds of environments using both, polarimetry and interferometry. I have been supervising master thesis for students in different areas where SAR was the common subject: archaeology, deforestation, subsidence, volcanism, etc. Some of the results have been and will be published in several conference proceedings (PolinSAR 2008, Fringe 2009, Living Planet Symposium 2010, etc.). As part of my tasks within the Science Strategy, Co-ordination and Planning Office, I have to contribute to the Eduspace project and I have been preparing a module focused on Latin America applications. As far as contacts with end-user organisations are concerned, I have been in frequent contact with users from all over Latin America, supporting education and promotion activities of the EOP-S department. I have been active in maintaining relations and meetings with Environmental and Space Agencies like CONAE in Argentina, INPE in Brazil and CIREN in Chile. Lastly, I am contributing to the coordination between my office and UNESCO in education activities exploiting EO in the framework of the World Heritage Initiative.

INTRODUCTION TO THE EARTH OBSERVATION EO PROGRAMMES OF THE EUROPEAN SPACE AGENCY (ESA)

Projects and tools for Education.

Ana Belén Ruescas Orient
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Education and capacity building in the techniques and interpretation of Earth Observation data (EO) must be included in the student curricula at an early age, long before the university level. By so doing, it would be possible to properly educate future professionals making decisions and managing projects concerning Earth environmental studies. In this speech, an overview will be presented of the European Space Agency tools and services that, together with other agencies and institutions, are on offer for teachers and students of EO. The presentation starts with a brief description of ESA and its EO programmes, as well as the different operative satellites and future missions. Some examples of EO applications are also shown. Tools available to schools (software, image catalogues, etc.) are shown in the second part of the presentation, with special emphasis on Eduspace and the School Atlas, products focused on the secondary level of education and where a significant amount of material on Latin America can be found.

EARTH OBSERVATION DATA APPLICATIONS IN CENTRAL AND SOUTH AMERICA

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Several case studies using EO data over central and South America are shown here. The objective is to explain the usefulness of remote sensing techniques and their applications to environmental studies, climate change, natural hazards, etc. An overview is made of different ESA projects that have used EO data. The first is the Diversity project, where different examples are provided of applications in biodiversity in the Mesoamerican biological corridor and the Mesoamerican Coral Reef System, mangrove mapping and wildlife migrations. The second consists of several examples of the Jaguar mini projects in Lake Titicaca, the oil and gas activity in Ecuador and urban services in Chile. The third makes highlights the Earth Observation Principal Investigator projects in Mexico and Peru, which are related to volcanology, seismology and subsidence with radar data. And lastly, some examples of the Charter Activations are shown, like flash floods in Mexico and Honduras, the effects of the hurricanes in Haiti and a volcano eruption in Chile.

CURSO PARA DOCENTES: LAS POSIBILIDADES DE LEOWORKS PARA LA DOCENCIA DE LA OBSERVACIÓN DE LA TIERRA EN CLASE

Ana Belén Ruescas Orient
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Día 1. Análisis espectral de imágenes MERIS

PRESENTACIÓN (30 minutos)
Hacer una presentación somera de LEOWorks y sus principales funciones.
Presentar los sensores que se van a utilizar: MERIS y SPOT

EJERCICIOS (3 horas)

1. Análisis espectral de MERIS Full Resolution sobre Costa Rica (1 hora)
    - Abrir una imagen en LEOWorks
    - Observar los distintos canales
    - Hacer una composición RGB
    - Leer los metadatos
    - Hacer una corrección geométrica
    - Análisis espectral
2. Detección de deforestación en Rondonia con LANDSAT (30 min)
    - Abrir imágenes y hacer composiciones RGB
    - Analizar los datos de las imágenes
    - Hacer una animación
    - Clasificación supervisada de las tres escenas
    - Análisis estadístico
3. Detección de áreas quemadas en Grecia con SPOT (1.5 horas)
    - Dos imágenes pre-evento/pos-evento
    - Abrir las bandas y hacer composiciones RGB
    - Hacer un recorte del área de interés
    - Corrección geométrica
    - Calcular el índice de vegetación
    - Utilizar el LUT para discriminar áreas quemadas/áreas no quemadas
    - Calcular área quemada (herramientas SIG?)

Día 2. Observación de las zonas urbanas

PRESENTACIÓN (30 minutos)
Presentar los sensores que se van a utilizar: Landsat y CHRIS/PROBA.

EJERCICIOS (2.5 horas)

1. Detección de cambios en Buenos Aires (Brasilia?)
    - Abrir imágenes/composición RGB
    - Ajuste del contraste

- Detección de cambios utilizando las herramientas SIG
- Crear un polígono del área de cambio y salvarlo en formato .shp
- Hacer una superposición del polígono salvado en la imagen sin cambio

2. Clasificación de una imagen hiper-espectral en Santa Rosa, California
    - Abrir imagen/composición en color verdadero
    - Abrir las 18 bandas
    - Clasificación supervisada: campos de entrenamiento/análisis estadístico/algoritmo paralipipedo
    - Corrección geométrica con puntos de control de Google Earth

Día 3. Observación de los océanos

PRESENTACIÓN (45 minutos)

Presentar los sensores que se van a utilizar: MERIS y AATSR
Presentación de otras herramientas gratuitas para la docencia en clase: BEAM

EJERCICIO CON BEAM (2 horas)

1. Color del océano en el Golfo de México
    - Abrir imágenes/paleta de color
    - Observar la diferencia entre las distintas bandas
    - Hacer perfiles: análisis espectral
    - Calcular un NDVI sobre las zonas en tierra
    - Proyección geométrica (imagen a mapa)
    - Corregistro MERIS/AATSR (imagen a imagen)

Prof. Dr. Jan Smit
Faculty of Earth and Life Sciences
Department of Sedimentology
Vrije University
Amsterdam, Holland

Dissertation: (PhD) May 11, 1981 (cum laude), at the University of Amsterdam
Thesis title: "A catastrophic event at the Cretaceous-Tertiary Boundary"

Employment:

Visiting assistant Professor of Geology, California Institute of Technology, Pasadena, California, U.S.A: October - December 1983.

Post-doctoral researcher, UCLA California, U.S.A. January: 1984-July 1985.

Research Fellow of the Koninklijke Nederlandse Academie van Wetenschappen (KNAW) (January 1989-December 1993)

Academic Researcher, department of Sedimentology, Faculty of Earth and Life Sciences,, VU University Amsterdam, (January 1994 -2003)

Professor Event-Stratigraphy, department of Sedimentology, Faculty of Earth and Life Sciences, VU University Amsterdam, (2003-present)

Awards and invitations

Recipient of the AKZO- Science Prize 1989

Recipient of the 1999 Mary Clark Thompson Medal of the National Academy of Sciences, Washington D.C.

Miller Visiting Professor, University of California, Berkeley, 1-30 November 1995.

Co-Chief scientist ("Principal Investigator") of the Chicxulub Scientific Drilling Project, a project of the International Continental scientific Drilling Program ICDP

Selected Publications

Schulte, P., , H. Brinkhuis, A. Kontny, P. Claeys, JSmit 2008, Comment on the paper: "Chicxulub impact predates K-T boundary: New evidence from Brazos, Texas" by Keller et al. (2007), Earth and Planetary Science Letters, v. 269, no. 3-4, p. 614-620.

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Smit, J., Gaast, S. J. v. d., and Lustenhouwer, W. T., 2004, Is the transition impact to post-impact rock complete? Some remarks based on XRF scanning, electron microprobe, and thin section analyses of the Yaxcopoil-1 core in the Chicxulub crater: Meteoritics and Planetary Science, v. 39, no. 7, p. 1113-1126.

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Smit, J., and Hertogen, J., 1980, An extraterrestrial event at the Cretaceous-Tertiary boundary: Nature, v. 285, p. 198-200.

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The Chicxulub Impact

By J. Smit

Faculty of Earth and Life Sciences

Department of Sedimentology

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At the end of the Cretaceous period a mass-extinction took place that eliminated not only the dinosaurs, but also many ecosytems in the ocean, in particular the pelagic realm. In 1973 Harold Urey(1) speculated that geological periods, e.g. at the end of the Cretaceous (the Cretaceous-Paleogene boundary, in short KPgB) could be linked to collisions of giant cosmic bodies with the Earth. Research(2) on the fossils, planktic foraminifers (unicellular protozoans), from the oceanic realm on the KPgB already indicated that, geologically speaking, the transition was extremely rapid. More importantly, there was no foreboding of the impending extinctions!

Planktic foraminifers are sensitive indicators of their environment. Some species stay on the surface 10m in their life span, others, the larger species, migrate to over 400m waterdepth and reproduce there. Some carry symbionts, others are grazers, a few are voracious carnivores. A few can tolerate different temperatures, but most are restricted to narrow temperature and salinity ranges. Specific assemblages belong to specific water masses. At the end of the Cretaceous these were divided into a Tehyan and Boreal realm, there were no large icecaps at the time. But whatever niche they occupied, of the 60+ species only a few survived the KPgB, may be only a single generalist species. If any significant climate change would have happened on the Earth preceding the KPgB, foraminiferal assemblages would have reacted to those changes, and none of them did!

Since the study of these foraminifers (and neither of the dinosaurs and mammals for that matter) did not yield a single clue of why they went extinct, several scientists realized that the clue might not lie on the Earth and its interrelated processes, but in outer space. Dale Russell speculated about a Supernova explosion, others looked at collisions of cosmic bodies. The first clue came (but unrecognized) with the detection of high Cr content on the K/Pg boundary in Denmark in 1973(3). But the telltale discovery was the anomalous enrichment of iridium in a clay-layer precisely at the KPgB In 1979(4). The iridium could not have originated from a supernova, because the isotope ratios of osmium and iridium, confined the origin of the Ir anomaly to our solar system. Therefore, my dear Watson, the impact of a large cosmic body on the Earth remained as the only reasonable explanation. Subsequently, microkrystites (5), shocked quartz grains(6), nanodiamonds, and finally an extraterrestrial 53Cr/52Cr ratio(7) were found in the KPgB clay, confirming a major impact somewhere on the Earth. But

where? Iridium abundance was more or less identical on all places on the world. Microkrystites (small <250mmm globules, with crystals condensed from a silicate vapor) occur everywhere in the same abundances. However, the size of shocked quartz grains increases towards North America. Moreover, shocked quartz points to an impact site on continental crust, rather than in the ocean, increasing the likelihood of finding the crater. Likewise, the thickness of the iridium-rich clay is thickest in the US Western Interior. Impact melt droplets were then found, also in North America, but the largest in Beloc, Haiti. Finally, In Texas, the remains of large tsunami waves (a tsunamiite in Brazos river) pointed to an impact in the Gulf of Mexico or the Caribbean (8).

Based on all these findings it almost came not as a surprise that in 1990 the crater was (re)discovered (9), the Chicxulub crater, in Yucatan, Mexico. The discovery was originally based on a coincidence of gravity and magnetic anomalies, similar to several other well known craters. The crater has subsided by about one kilometer since 65 million years ago, and is covered by thick layers of sediment that protected the crater from erosion. The crater is therefore not accessible at the surface, even not visible at the surface except by sensitive satellite radar observations, and a ring of sinkholes, cenotes. The KPgB in the direct surroundings of the crater is often excellently preserved, and yields a wealth of information about the distribution of tektites and tsunamiites.

In 1995 the Chicxulub deep drilling program CSDP was initiated, and realized in 2002 its first core, Yaxcopoil-1, in the crater itself, about 70 km from the crater center. The drill core recovered about 800m of post impact crater infill, 100m of ejecta, and 500m of pre-impact target rocks. Expectations ran high for the results of this core, but also led to many controversies. However, one important fact surfaced from the core: the Chicxulub impact vaporized enormous amounts of gypsum/anhydrite (CaS04), which ended up as aerosols in the atmosphere. The aerosols reflect effectively sunlight back into space, leading to a short cooling on the earth surface, as recorded by dinoflagellate migrations (10)

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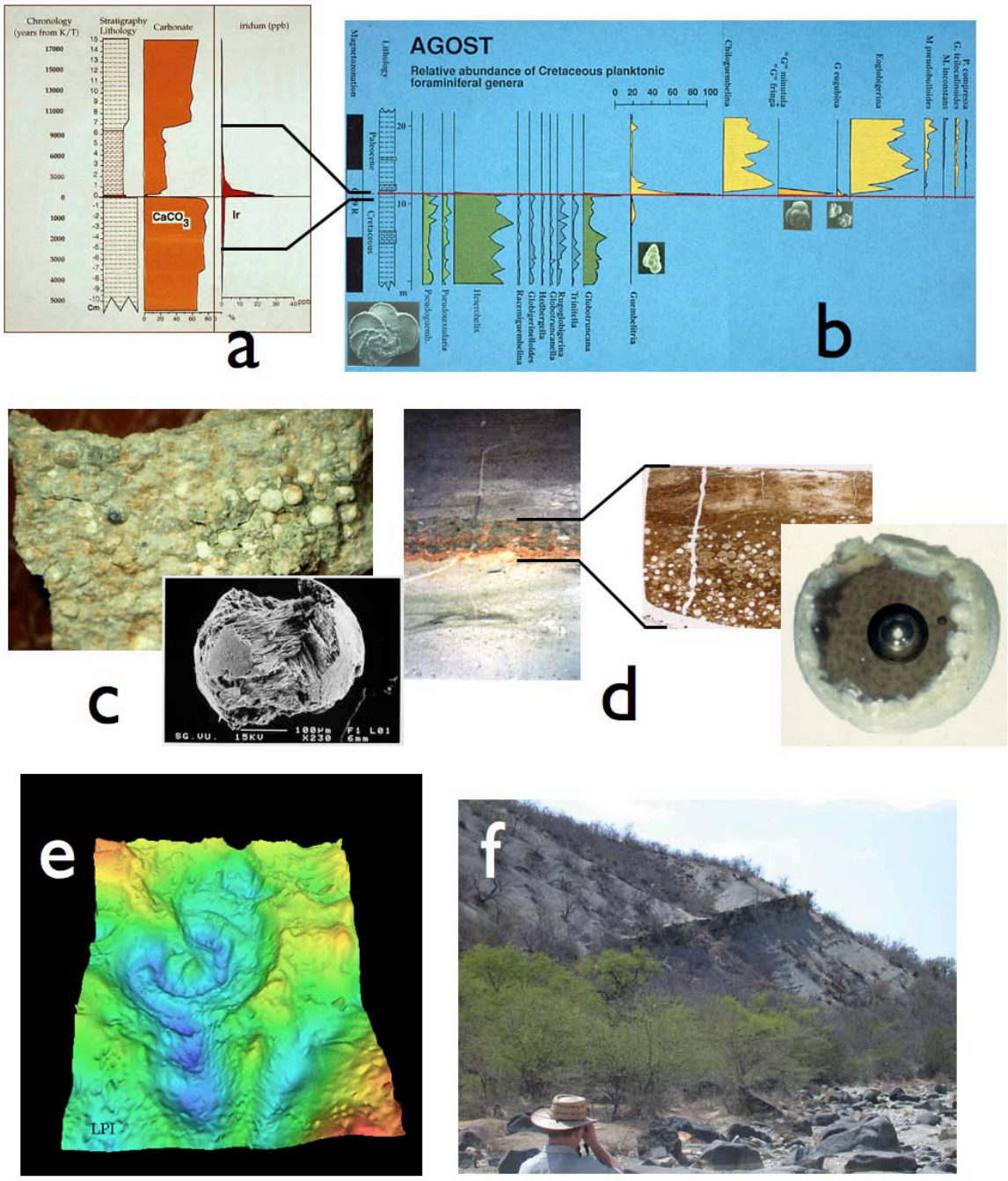

a) iridium anomaly at the KPgB of Agost Spain. b) planktic foraminiferal abundances around KPgB at Agost Spain. c) microkrystites in the Ir rich layer at Agost (inset: SEM image of a microkrystite of ODP site 577 from the Pacific) d) Comparison of the 3mm thick Ir clay at Agost with the 2cm thick layer in Dogie Creek, Wyoming. (Inset: tektite with bubble from Beloc, Haiti) e) computer generated image of the Gravity anomalies of the Chicxulub crater. F) 2m thick tsunamiite at the KPgB near El Mulato, Mexico.

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Dr. Ana Lillian Martin- Del Pozzo, Instituto de Geofisica. Departamento de Vulcanología, Universidad Nacional Autonoma de Mexico, Professor of Earth Science and Volcanology, Leads projects on volcanic behavior and hazard evaluation on Popocatepetl and Colima Volcanoes and the Chichinautzin monogenetic field.

Participant in international projects with Italy, Chile and United States. Author of 55 articles and 7 chapters in books on volcanic impact, magma ascent and volcanic precursors. Author of two Volcanic Hazard map. Active in international media presentations on Volcanic Hazards. .Mexican Ministry of Gobernación (Interior).and Popocatepetl National Park Advisory Committees. Participates as both graduate and undergraduate advisor.

Volcanoes and their impact on society

Ana Lillian Martin Del Pozzo

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Volcanoes have been linked to human settlements, because of the presence of water, fertile soils and beautiful landscape, but in many cultures they have also been worshiped as deities. Central Mexico is no exception; for at least 4000 years the local inhabitants have linked the fire God with Xitle volcano that covered the Cuicuilco pyramids in southern Mexico City with lava flows and also with nearby Popocatepetl Volcano, the smoking mountain that erupts explosively about every 1000 years but also has smaller eruptions each century. Since 1994, Popocateptl has been erupting ash associated with the formation and destruction of crater domes. This ash has caused problems with air traffic and health but the main impact has been from the small mudflows that have reached two towns. Nonetheless, due to increased activity, the many towns set on the volcano have been evacuated recently in 1994 and 2000. During the 2000 eruption, the 17km plume was accompanied by pyroclastic flows and mudflows that reached outside the towns.

Another very active volcano that has also been populated for a long time is Colima Volcano in western Mexico. About every 100 years, Colima has an explosive eruption and the activity now is very similar to that which precedes this type of eruption, the crater is filled now by a large dome which would explode producing pyroclastic flows that would reach 15 km from the volcano as well as ash over a good part of the country. Authorities are well acquainted with the hazard maps so this will help mitigate the effects.

Two very different eruptions from Mexican volcanoes are probably the most famous; Paricutin Volcano was born in a corn field in 1943 and quickly built up its cone which was well studied by the scientific community at the time. The eruption which lasted nine years was painted very descriptively by Dr. Alt, one of the muralists. The town of San Juan Parangaricutiro had to be relocated since it was covered by ash and lava. Today one can still visit the lava flows inside the church. The other eruption which impacted not only the area in southeastern Mexico, but even world climate due to the amount of ash it emitted into the atmosphere in 1982, was Chichon. The eruption lasted about a week but the pyroclastic flows and ash fall buried several villages causing around 2000 casualties and severe economic loss. On the other hand, due to the heavy rains in the area about one month after the eruption, much of the vegetation had grown again.

GERALD H. HAUG
Professor ,
Climate Geology,

ETH Zürich

Education

2002	Habilitation**, ETH Zürich** „ Late Cenozoic Paleoceanography and Climate“.
1995	**Dr. rer. nat.**, Universität Kiel (‚magna cum laude’) Paleoceanography and sedimentation history in the northwest Pacific during the last 6 million years (ODP-Site 882)“.
1992	**Diplom** in Geology, Universität Karlsruhe „The volcano-tectonic evolution of the northern Chyulu Hills, South Kenya“.

Experience/Positions held (selection)

06/07-	Professor ‚Climate Geology’, ETH Zürich
06/07-	Guest Professor , University of Potsdam
04/03-05/07	Professor (C4), University of Potsdam and Geoforschungszentrum Potsdam (GFZ)
01/00-12/02	Oberassistent, ETH Zürich
01/98-12/99	Research Assistant Professor, University of Southern California
02/97-01/98	Post-Doctoral Guest Investigator, Woods Hole Oceanographic Institution
10/96-02/97 British	Visiting Scientist, Department of Oceanography, University of Columbia (UBC), Vancouver, Canada
12/95-12/97	Postdoctoral Research Associate, GEOMAR, Center for Marine Geosciences, Kiel, Germany
10/92-12/95 Germany	Ph.D. Student at the Geological Institute, University of Kiel,

Honours

11/01	Albert Maucher Preis (Deutsche Forschungsgemeinschaft - DFG)
12/06	Gottfried Wilhelm Leibniz Preis (Deutsche Forschungsgemeinschaft

DFG)
08/08 Member of the Academia Europaea

5 Key Publications

Haug, G.H., Ganopolski, A., Sigman, D.M., Rosell-Melé, A., Swann, G.E.A., Tiedemann, R., Jaccard, S.L., Bollmann, J., Maslin, M.A., Leng, M.J. & Eglinton, G. North Pacific seasonality and the glaciation of North America 2.7 million years ago. **Nature**, doi:10.1038, 1-5 (2005).

Haug, G.H., Günther, D., Peterson, L.C., Sigman, D.M., Hughen, K.A. & Aeschlimann, B. Climate and the Collapse of Maya Civilzation. **Science** 299, 1731-1735 (2003).

Haug, G.H., Hughen, K.A., Peterson, L.C., Sigman, D.M. & Röhl, U. Southward migration of the Intertropical Convergence Zone through the Holocene. **Science** 293, 1304-1308 (2001).

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Climate and Environmental Change and Early Civilizations

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A unifying theme in paleoclimate research is well summarized by a piece of advice that I once heard the late Sir Nicolas Shackleton give to an audience of paleoceanographers: "Whatever you do, do it in high resolution." The underlying message, I believe, is that much 'noise' in geologic records is actually composed of meaningful environmental signals. A central goal is to use new approaches and techniques that do justice to the complexity of geologic records, in order to allow previously hidden signals to emerge.

On the millennial to subdecadal timescale, climate archives with an appropriate memory are anoxic marine basins and lakes. In the anoxic Cariaco Basin off northern Venezuela, millimeter to micrometer-scale geochemical data in the laminated sediments of the Cariaco Basin have been interpreted to reflect variations in the hydrological cycle and the mean annual position of the Intertropical Convergence Zone (ITCZ) over tropical South America during the past millennia. These data with decadal to (sub)annual resolution show that the Terminal Collapse of the Classic Maya civilization occurred during an extended dry period from 700 to 900 AD. Data of comparable quality and resolution have been extracted from sediments of lake Huguang Maar in coastal southeast China. The record indicates a stronger winter monsoon prior to the Bølling-Allerød warming, during the Younger Dryas, and during the middle and late Holocene, when cave stalagmite oxygen isotope data indicate a weaker summer monsoon. A remarkable similarity in the records of ITCZ migration in east Asia and the Americas from 700 to 900 AD raises the possibility that the coincident declines of the Tang Dynasty in China and the Classic Maya in Central America were catalyzed by the same ITCZ migrations. Comparison of our records with the Chinese dynastic history suggests that drought played a role in the terminations of Dynasties during the past 4000 years.

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Education

PhD. Geophysics, Instituto de Geofísica, UNAM, March 2002. With honors. Alfonso Caso Medal, to the best 2002 Promotion PhD Thesis.

Experience

• Director, Center for the Studies on Water, CICY, A.C, January 2005-August 2009.
• Senior Research Scientist, Centro para el Estudio del Agua, CICY, A.C., since May 2007.
• Research Associate, Centro para el Estudio del Agua, CICY, A.C., May 2004 to May 2007.
• Post-doctoral fellow at Laboratoire des Sciences du Climat et de l'Environnement, Unité Mixte de Recherche CNRS-CEA, Gif-sur-Yvette, Francia. October 2002 to April 2004.
• Post-doctoral fellow, Instituto de Geofísica, UNAM, March 2002 to September 2002.
• Chief of the Digital Documentation laboratory of the Core Respository fo the Chicxulub Scientific Drilling Project. December 2001 to March 2002.
• Chief of the Digital Documentation laboratory of the Core Respository fo the UNAM Scientific Drilling Project. 2001.
• Responsible of the Chicxulub Shallow Drilling Project Core Repository, UNAM, 2000 to 2002.

Oceanographic campaigns

• Picasso, Leg 2, R/V Marion Dufresne, IFEP, June, 2003.
• FAMEX, Leg 1, R/V l'Atalante, IFREMER-UNAM, March, 2002.
• Seeps, R/V Atlantis, Univ. Of Oregon, April, 2001.
• Sedimentos III, R/V El Puma, UNAM, April, 2000.
• Plume, Leg 3, R/V Thomas Washington, SCRIPPS-CICESE, July, 1991.

Teaching Experience

• Teacher assitante to Dr. Avto Gogichaisvili, course: Paleomagnetisme and environmental
magnetism, Posgrado en Ciencias de la Tierra, UNAM, 2000 to 2001.
• Teacher, Physics, "Curso de Introducción a las Ciencias de la Salud", Medicine School, Universidad Anáhuac, 1999.
• Instructor, Topography, Facultad de Ciencias Marinas, U.A.B.C., 1997

• Teacher, Non-renewable marine resources, Facultad de Ciencias Marinas, U.A.B.C., 1994
• Teacher, Structural Geology, Facultad de Ciencias Marinas, U.A.B.C., 1993

The hydrogeology of the Yucatán Peninsula

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GIFT Workshop, Mérida, Yucatan, March 2010

The only surface expression of the Chicxulub Impact Crater is a Ring of Sinkholes (locally called Cenotes) (Figure 1). The density of the cenotes varies from several cenotes per kilometer, to several kilometers between each cenote. This ring has a radius of approximately 90 km and it is centered at Chicxulub Puerto. The hydrogeological significance of the Ring was investigated by scientist since 1990. It is not known today whether the Ring of Cenotes is the surface expression of the transient cavity as some authors have suggested, or whether it is the outer rim of the impact structure as other authors have suggested. The center of the ring is approximately coincident with the center of the Chicxulub Impact Crater. Reactivation of K/T rim faults had been suggested by Hildebrand et al., (1991), and Pope et al. (1996) as associated to the formation of the Ring of Cenotes. Several seismic reflection surveys have shown the limits of the Chicxulub impact basin as marked by a system of normal faults. British scientits conducted a seismic experiment that complemented the seismic lines from PEMEX. From their model, we can see that the cenote ring is coupled with one of these fault systems. However, none of these models project such faults to the Tertiary sedimentary sequence; therefore we can only infer that the cenotes are associated to these faults.

Other hypotheses include "post impact subsidence induced by slumping and viscous relaxation in the rim" and "slumping in the rim of the buried crater, differential thickness in the rocks overlying the crater, or solution collapse within porous impact deposits". Some researchers suggested a long duration of subaerial exposure and weathering as a principal reason both for difference in permeability and cenote density inside and outside the Ring. This is consistent with the evolution of surface features reported by Pope et al (1996). While sedimentation occurred in the basin outlined by the Ring, erosion and karst weathering were taking place outside the ring.

Other researchers report that the karst features are associated with gravity gradients, which others interpreted as corresponding to peripheral faults of the buried crater. From this model, we interpret the faults as weakness zones with high permeability. This fault system probably generates a secondary porosity with high permeability that allows the circulation of water, which, in turn, will dissolve the carbonates of the roof and hanging walls of the faults. However, this model implies that the late Tertiary geomorphic feature can retain a memory of a Cretaceous-Tertiary boundary event. The absence of any seismic activity at present, associated to these “active fault zones”, does not support this hypothesis; nonetheless another array of cenotes, that is not related to the ring of cenotes, is the alignment of >100 km long chains of elongated solution depressions locally known as sabanas along the Holbox fracture zone-Xel-Ha zone; these alignments support the hypothesis of a generation of karst features associated to weakness zones in major fractures zones, such as Holbox fracture zone-Xel-Ha zone and the Chicxulub crater rim. Perry et al. (1992) also proposed that a circular reef complex may have formed in the Paleocene sea

above ejecta material at the crater rim and that this later became a favored ground-water flow channel; however, no direct evidence supports this model.

The scientific activity, prompted by the discovery of the Chicxulub Impact Crater in the Northern Yucatan Peninsula, covers a wide range of disciplines, from geochemistry and planetary sciences, to paleontology and hydrology. Today, the Northern Yucatan, is the region with the most hydrologic studies in the Peninsula. The study of the structure and morphology of the crater has allowed researchers to understand the key role of the crater in the Yucatan hydrogeology. We know now that the Ring of Cenotes, produced by the gravitational deformation of the Tertiary sedimentary sequence within the crater, controls the groundwater in Northern Yucatan. Today, more than half a million persons live within the crater, therefore, understanding role of the crater on the local hydrogeology and its implication on the management of the aquifer, gives a new importance to continue the studies on the Chicxulub Impact Crater.

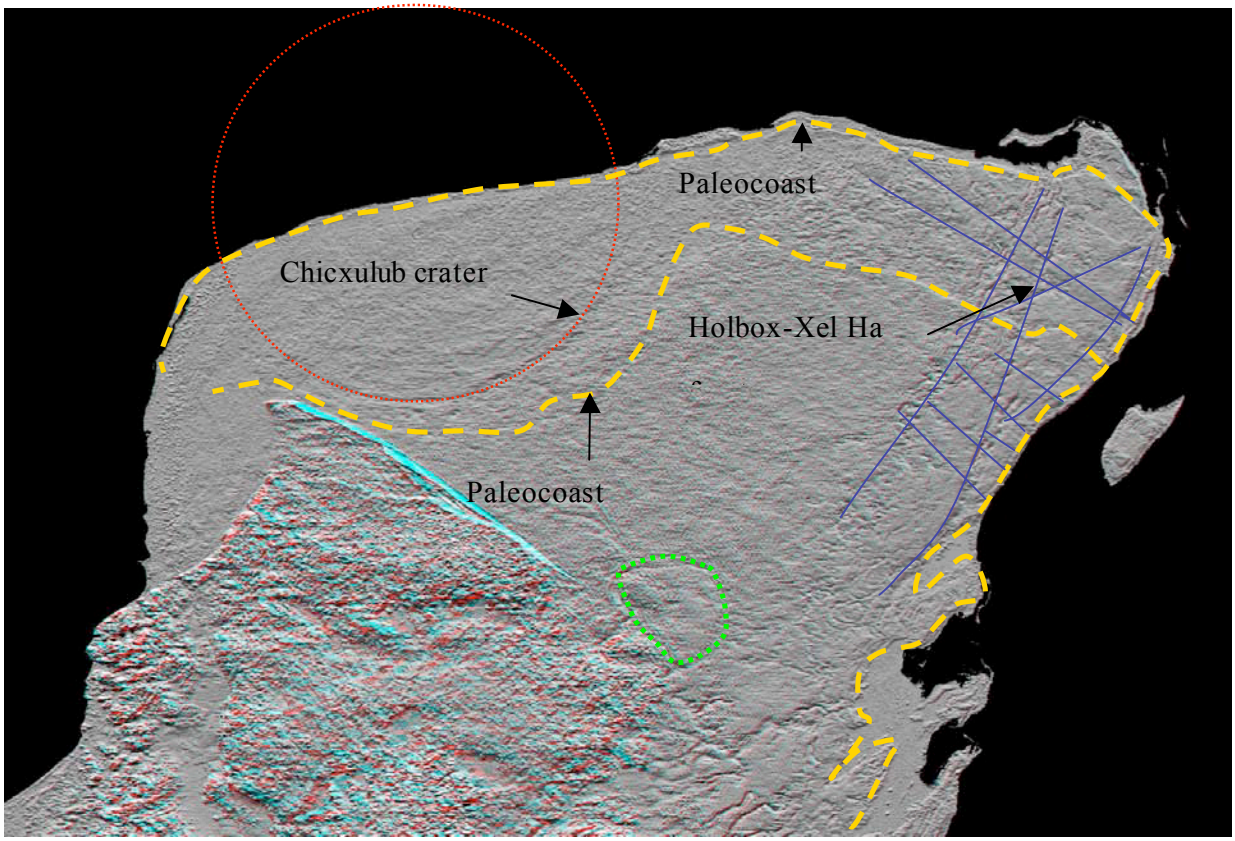

Figure 1.- Interferometry radar image from NASA (2000), showing the main topographic features of the northern portion of the Yucatan Peninsula. The southern portion of the Chicxulub crater is correlated with the ring of cenotes, on the eastern portion of the Peninsula, within the Holbox-Xel Ha fracture zone is also correlated with a large number of cenotes.

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EDUCATION

Ph.D. Ocean Sciences (Geological Oceanography) UNAM (National University of Mexico).
Dissertation: Holocene paleoceanographic and sedimentological study of the Bay of La Paz, Gulf of California, Mexico). Graduated *summa cum laude* 2000

RESEARCH INTERESTS

Paleoceanography, paleoclimatology, geochemistry and sedimentology
Micropaleontology (radiolaria, silicoflagellades, and benthic foraminifera)

AWARDS AND RECOGNITIONS

Cowen Award Committee Member, American Geophysical Union (2008-2010)
Award for the best doctoral thesis on Geological Oceanography from UNAM (2001)
Alfonso Caso Medal for outstanding academic student performance from UNAM (2000)
Masters graduated *summa cum laude*, UNAM (1989)

PROFESSIONAL AFFILIATIONS

American Geophysical Union
Third World Organization for Women in Science
Mexican Geophysical Union
Mexican Union for Quaternary Studies

Research Experience

December 2004-present. Researcher, Institute of Geophysics, Department of Geomagnetism and Exploration, UNAM (National University of Mexico)
2002-2004. Researcher. Mexican Petroleum Research Institute
1994-1997. Chief of Electron Microscope and X-ray Analysis Laboratory. Mexican Petroleum Research Institute. Geosciences Division

PROJECTS RESEARCH INVOLVEMENT

Late Pleistocene-Holocene climatic variability in the southern Gulf of California. Chief researcher.
Study of the Paleoenvironments of the late Cretaceous and Paleogene in the Chicxulub Impact Site, collaborating with the interpretation of geochemical data (stable isotopes).

Oceanographic and Meteorological parameters for the assessment and design of fixed structures and submarine lines in the oil industry along the Tabasco littoral zone. Subproject: Oceanography. Chief researcher. IMP-PEMEX (Mexico´s state-owned petroleum company).
Hydrocarbon emanations into the sea. IMP, collaborating with the geochemical analysis.

TEACHING EXPERIENCE
Lecturer Faculty of Sciences, UNAM, Mexico City. Paleobiology, Earth Sciences, Paleoceanographic and Paleoclimatology, and Paleontology
Scanning electron microscopy and X-ray microanalysis applications in Geosciences in the IMP (Mexican Institute of Petroleum)

14 papers in journals, 46 congress abstracts and more than 20 oceanographic campaigns in the Gulf of Mexico, Gulf of California and Pacific Ocean

Paleoclimatic records: clues to explain climate variability

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In the planet, global climate -like local weather- is ever changing, on all time scales, in response to natural variations. From observed changes in the historical record, the conclusion is evident that climate change would have large societal impacts through effects on global ecology, hydrology, geology, and oceanography. To predict climate, climate variability, and climate change depends upon an understanding of global processes. Human impacts are primarily terrestrial, but the major forcing processes are atmospheric and oceanic and they are transferred through geologic and biologic systems. A variety of phenomena generate permanent records of natural processes that are governed by climate. Information obtained from such indirect preservation of climatic history is generally referred to as proxy data to distinguish it from direct instrumental measurement.

The natural records are commonly used to reconstruct proxy climatic histories and are grouped into two major categories based on weather they provide episodic or continuous records of climatic variability. Depending upon the temporal scale of variability preserved, the continuous records are further classified as low-, intermediate-, and high resolution. Continuous low-resolution records are best exemplified by depositional environments in the deep sea with relatively slow sedimentation rates and by the deep sections of the polar ice sheets. These archives preserve the events of climatic change occurring over millennial time scales, for example, glacial–interglacial variability in the Quaternary. Resolution of centennial through decadal variability (the intermediate scale), is preserved in the intermediate depths of polar ice and lake and marine sediments along continental margins. High resolution archives all generate visibly distinct layering as a response to climatic variation from one season to the next. These records result from growth of living organisms which produce structures such as tree-rings and coral banding, or from complex depositional processes producing dust layers within glacial ice, and the

lamina couplets in varved marine or lacustrine sediments. The dominant climatic signal preserved in these records is an annual cycle.

For example, tree-ring widths tell of seasonal variations of local air and water conditions. The extent and composition of coral reefs are indicators of tropical ocean temperatures and, through changes in ocean salinity, of local precipitation. The presence of forests and other vegetation, which are indicators of climatic conditions, can be reconstructed from the analysis of pollen in lake sediments. Cores with laminated sediments extracted from the floor of the ocean to allow examine microfossils that once lived near the ocean surface, and through this analysis, to recover information about the temperature of the ocean many millions of years ago. A particularly technique of recent years has been the recovery and analysis of ice cores, drawn from the permanent glaciers on Greenland and Antarctica. Similar samples have been recovering from high mountain glaciers in South America. As in the case of trees, the ice is composed of annual layers.

All these archives are particularly valuable for their preservation of the year-to-year or interannual scale of climatic variability. These natural records may also store environmental information by more than one mechanism, thus providing several proxy variables as separate recording signals. When combined, these various forms of *paleo-data* allow us to reconstruct an imperfect but ever-clearer picture of the climate of the past. All of them clearly indicate that climate varies, due to natural causes, on all time scales, from decades to millions of years.

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Education*:* Engineering Geologist, Faculty of Engineering, Universidad Nacional Autónoma de México (UNAM), 1988. Master of Science: Faculty of Science, 1991. Ph.D. UACPyP -CCH, UNAM, 1996.

Professional Experience: Suzana Alaniz began working as academic technician in 1696 at the Instituto de Geologia, UNAM. She is now working as a senior scientist at Centro de Geociencia, UNAM

Research interest*:* She specializes in Structural Geology, focuses her studies on the brittle deformation of the crust and its relationships with volcanism.

Teaching*:* She has given courses for teachers in various universities, currently offers the course Structural Geology, postgraduate level, at the Centro de Geociencias, UNAM. In 2009 she started the program "Chain for Science", which is a workshop focused on Earth Science for basic teachers in the State of Querétaro, México.

Honors and Awards*:* Member of the Sistema Nacional de Investigadores (SNI) since 1986, actually at level II. 2. Member of the Mexican Academic of Science since 1994. Member of the Engineering Academy since 2002, Juana de Asbaje Prize in 2004, and at level D of the Program of Incentives of the academic staff.

Publications: 38 articles in refereed international journals, 3, geological maps, several monograph chapters, 3 books, and 2 softwares. Editor in chief of the Revista Mexicana de Ciencias Geológicas; member of the editorial board of the Boletín de la Sociedad Geológica Mexicana. Editor of the books: "Experimentos simples para entender una Tierra complicada" and "Léxico Geológico Mexicano".

Promoting geoscience interest in youngsters

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There is a lot of information related with the Earth phenomena that are presented each day in the scientific media. Most of this information is incomprehensible by the society, maybe because they don´t have a solid preparation in science matters or may be because they are not interested.

In order to attack these problems we propose a classroom workshop to promote science interest in children. The main target of this workshop is explain basic physics concepts by doing experiments that will be used to understand many of the geologic phenomena that are around us. Waves, mass, weight, density and buoyancy are basic to understand volcanism, earthquakes, tectonic plates theory, the climate, among others phenomena. To increase the interest in science in children, we try to relate the experiments with their daily activities.

The workshop consist to do simple experiments with readily available materials and is based on the books of the serie "Simple experiments to understand a complicated Earth" published by the Centro de Geociencias, UNAM. Each book has about eight experiments including one of the most famous and ancients' experiments of Physics. One book is dedicated to the Galileo´s experiment of the falling bodies (1600), and it is shown how the velocity of falling is not dependent of the weight but the air friction, thus there are a lot of explanations related with gravity and the atmosphere. Another book is dedicated to the Arquimedes´ experiment of buoyancy, in this book there are experiments related with density and explanations in how the buoyancy acts in the volcanism eruptions, isostasy, climate and tectonic plates theory. A third book is dedicated to the Newton´s experiment of the decomposition of sunlight with a prism (1666), there are also experiments related with the properties of light. This information not only explains how the colors of nature are produced but also to understand many of the properties of waves.

All the material (instructions, the books in pdf format, material needed, questionnaires and their answers) for this workshop is in the web page:
http://www.geociencias.unam.mx/geociencias/experimentos/experimentos.html.