



CHRONOS



www.chronos.org

NSF-EAR 0315216

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Earth system history research depends increasingly upon the analysis of voluminous, multidisciplinary, time-calibrated data. *CHRONOS* is a community resource dedicated to making available Earth history data and information, together with a toolkit to analyze and visualize them, to the broad geoscience community, the public, K-16 students and educators, policy-makers, and the media. This international interactive network of paleobiology, biostratigraphy, radioisotope geochronology, and sedimentary geochemistry data is made accessible through a common portal (www.chronos.org) and has been funded by the National Science Foundation since August 2003.

US PARTNERS

GEON (www.geongrid.org) - *CHRONOS* is a Point of Presence on the GeonGrid and contributes paleontological and stratigraphic data and time scale tools (e.g., 2004 Global Time Scale, stratigraphic color schemes, time scale conversions) as web services to the GeonGrid.

PaleoStrat (www.paleostrat.org) - *CHRONOS* main data engine designed to include sample-based lithological, paleontological, geochronological data.

EARTHTIME (<http://www-eaps.mit.edu/earthtime/>) - *CHRONOS*/PaleoStrat as geochronological data repository.

GeoSystems (<http://geosystems.ou.edu/>) - *CHRONOS* is working with this community-based science initiative to provide data networking and analytical tools.

ANDRILL (<http://andrill-server.unl.edu/>) - This NSF-OPP funded project has designated *CHRONOS* as their main chronostratigraphic data repository.

IODP - *CHRONOS* is working with IODP to network the Janus database. IODP will clone Janus and create JanusLegacy containing all released data by

October 2004. JanusLegacy will be updated at regular intervals as new data are entered into Janus and be accessible to any group that would like to connect to it. *CHRONOS* will network JanusLegacy as soon as it is completed.

INTERNATIONAL PARTNERS

International Commission on Stratigraphy: *CHRONOS* is using ICS's 2004 Global Time Scale and is working with the various sub-commissions to develop concepts for the calibration of regional time scale to the global time scale. *CHRONOS* is hosting ICS's web domain, www.stratigraphy.org.

"*CHRONOS Europe*": Scientists from Germany (e.g., Humboldt Museum in Berlin, Stratigraphy.net, Pangaea), France, UK (e.g., Natural History Museum in London, University College London), Norway (University of Oslo) and officers of various national science foundations will meet in Florence in August 2004 to discuss about partnerships with *CHRONOS* and other GeoInformatics projects.

"*CHRONOS Australia*": *CHRONOS* is partnering with CSIRO, Geoscience Australia, and geoscientists at the Australian National University to expand the network to include data from Australian databases and to collaborate on time scale services. A kick-off meeting has taken place in Sydney on June 9, 2004.

JCORES/CHIKYU/IODP: *CHRONOS* has offered to partner and network with JCORES to provide taxonomic and stratigraphic data.



DATA

CHRONOS is a network of federated and hosted databases and data files. Currently, users can access through *CHRONOS*'s web interface three networked databases. One of these databases (Neptune: a relational database of close to 400,000 age-calibrated Cenozoic marine plankton occurrences from DSDP and ODP cores currently being populated with Mesozoic data and post-1997 ODP sites) is hosted at *CHRONOS* IT hub. The other two (PaleoStrat and the PaleoBiology database) are federated, i.e. located elsewhere and independently managed. A list of data files currently available at *CHRONOS* is given in the Appendix.

PALEOBIOLOGY AND BIOSTRATIGRAPHY

Taxonomic information is available both in Neptune (Mesozoic and Cenozoic marine plankton) and PaleoStrat. *CHRONOS* is currently hosting an online Atlas of Paleocene Planktonic Foraminifera and a taxonomic dictionary for Mesozoic planktonic foraminifera in a relational database with images. The 14

participants to the *CHRONOS* workshop for Mesozoic planktonic foraminifera (May 20-22, 2004) have established a working group with the task to complete the dictionary by May 2005.

We are collaborating with the Neogene Marine Invertebrate in Tropical America database with the purpose of networking its content with *CHRONOS* data.

CHRONOS is discussing a partnership with the Treatise for Invertebrate Paleontology (Univ. Kansas) to upgrade and network their PaleoBank database.

SEDIMENTARY GEOCHEMISTRY

Since its conception in November 2001, *CHRONOS* has been designed to include marine and terrestrial time-calibrated data pertaining to Earth history, i.e., paleontological, geochemical, geochronological, and magnetostratigraphic data, that are used to study Earth system processes throughout the whole geologic timescale. This is to be accomplished by partnering with others working on portions of this portfolio, or, when necessary, building the necessary databases. *CHRONOS* organized and sponsored a workshop entitled "Geochemical Cycles through Time" (June 25-26, 2004) attended by 28 sedimentary geochemists, chemostratigraphers, paleoceanographers, and modelers. The goals were to identify data sources and discuss the data and tools need of this community within the geosciences. Some of these data are currently available digitally at data repositories like e.g., NGDC, as individual, variously formatted and often not thoroughly documented files. The outcomes of the workshop is *CHRONOS*, its partners, and in collaboration with the emerging SedDB project, will work to develop an integrated database for time-calibrated geochemical data that should include all kinds of geochemical data related to Earth history and related geographic, stratigraphic, analytical, and sample quality information to make it as comprehensive as practical to allow for data evaluation and later reevaluation. Graphic correlation, geographic visualization, and age model tools should also be developed for data analysis

DATA INTERFACES

Networked data can be currently accessed through a web interface. A beta version of *CHRONOS* GIS interface (currently being tested with Neptune data) with paleogeographic projection is being worked on in collaboration with PaleoStrat. We are working with Gplates (www.gplates.org) and ODSN (<http://www.odsn.de>) to adapt their interactive plate tectonic reconstructions for *CHRONOS*/PaleoStrat data.

GEOLOGIC TIME SCALE

The 2004 Global Time Scale of the International Commission of Stratigraphy has been rendered as an online dynamic, interactive database that includes stratigraphic nomenclature (e.g., eon to age names), boundary ages and the

data used to construct the time scale itself (GSSP data etc.). Web services are available for partners and other users to seamlessly access the latest time scale information. Web services were also created to convert between the most commonly used time scales.



WORKING GROUPS

CHRONOS, PaleoStrat, and others of the IT team work closely with domain scientists during the development of the network databases and tools, and following *CHRONOS*-sponsored and co-sponsored community workshops, we have established various working groups in the two main domains that we are working on, geochemical cycles/paleo geochemistry and paleobiology/biostratigraphy. A third working group for radioisotope geochronology is being developed in conjunction with EARTHTIME. A working group for Education and Outreach is also in the planning. The role of the working groups is: (1) help design and review specific aspects of database schemas, metadata categories, and visualization and computational tools; (2) serve as experts to answer queries from IT specialists; and (3) enlist community support for populating the databases. The working groups are open to any scientist who is willing to actively participate, and we are striving to have this groups cosponsored by other projects when appropriate. The list of current working group members is available on line at <http://www.chronos.org/workinggroups.html>.

OUTREACH TO THE GEOSCIENCE COMMUNITY

CHRONOS is sponsoring a topical session on geologic time and Geoinformatics at the next Annual GSA meeting in Denver (Nov 7-10 – 30 oral and 17 poster presentations with keynote addresses by M. Leinen, NSF; M. Benton, Bristol University; K. Hsu, Nanjing University; W.B.F. Ryan, LDEO) and a special session on taxonomic dictionaries at the North American Paleontological Conference in Halifax (June 2005). A session on calibration of the geologic time scale was organized at the Cordilleran/Rocky Mountain GSA last May. *CHRONOS* is also present in the exhibits at GSA and fall AGU meetings. A workshop on Mesozoic/Cenozoic paleoceanography is going to take place in St. Petersburg FL in October 2004 and one on cyclostratigraphy is planned for January 2005 in Baltimore. *CHRONOS* was also mentioned last fall in Nature, Science, Geotimes and in a syndicated article that appeared in various regional newspapers.

COMMUNICATION TOOLS

Workshop and meeting announcements are put on line on *CHRONOS'* web page. Monthly newsletters that summarize *CHRONOS* activities and progress are published on line. On line discussion forums are available for discussions on specific topics: geologic time scale, sedimentary geochemistry,

Information Technology. Forums and wiki pages are available to discussions among steering committee members and for IT developers.

COMMUNITY INVOLVEMENT AND EDUCATION

CHRONOS is partnering with Tapestry of Time (UCMP), the Smithsonian Institution, AGI, AGU, NAGT, NESTA, USGS, EARTHTIME, and geoscience educators to develop educational resources that 're-humanize' scientific discoveries that have led to our current understanding of Earth history, and virtual reality applications aimed at conveying the concept of deep time and visualizing the processes involved in some of the most significant milestones in the history of Earth.



***CHRONOS* MANAGEMENT**

STEERING COMMITTEE

Sam Bowring (MIT), Cinzia Cervato (Iowa State University), Linda Hinnov (Johns Hopkins University), Brian Huber (Smithsonian Institution), Mark Leckie (University Massachusetts, Amherst), Charles Marshall (Harvard University), Jim Ogg (Purdue University), Pete Sadler (University California, Riverside), Bruce Wardlaw (USGS).

ADVISORY BOARD

Dave Anderson (NOAA), Timothy Bralower (PennState), Felix Gradstein (ICS and University of Oslo), Kirk Johnson (Denver Science Museum), Doug Walker (University of Kansas), Ron Waszczak (Conoco Phillips).

IT DEVELOPERS

Doug Fils (Iowa State University, developer and project leader), Geoff Bohling (Kansas Geological Survey, developer, geostatistics), Pat Diver (Houston, DBA), Doug Greer (SDSC, network developer), Josh Reed (Iowa State University, undergraduate student and XML developer), Tyson Taylor (Boise State University, GIS), Xiaoyun Tang (Iowa State University, systems support specialist).

EXECUTIVE DIRECTOR AND IT, OUTREACH, AND EDUCATION COORDINATOR

Cinzia Cervato (Iowa State University)

Appendix

Data files submitted to CHRONOS (as of July 25, 2004). Unless indicated otherwise, the data are part of peer-reviewed publications.

1. Mollusk oxygen and carbon isotope database (Grossman, TAMU) - It is still being compiled and is not publicly accessible yet (~6500 samples)
2. Permo-Carboniferous $\delta^{18}\text{O}$, $\delta^{13}\text{C}$, and Sr/Sr data from mollusks (US and Russia; ~1,500 samples)
3. Atlantic Oligocene Benthic Forams (Katz, Rutgers) - species list with percent occurrence by sample (268 samples)
4. Phytoplankton occurrence data (Katz, Rutgers)
5. Phanerozoic CO₂ Trends (Royer, PennState) - compilation of $\delta^{13}\text{C}$ proxies (~340 samples)
6. PMCID database (Shields & Veizer) – compilations of published isotope ratios: Phanerozoic $\delta^{18}\text{O}$ data (5225 samples); Precambrian oxygen, carbon, strontium isotope and selected trace element data (12,700 samples)
7. Cenozoic seawater sulfate sulfur isotope data (Paytan, Stanford)(140 samples)
8. Otolith carbon and oxygen isotope data (Ivany, Syracuse University)(780 samples)
9. Phanerozoic strontium isotope ratios (McArthur, University College London)(221 samples)