

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 14-1 NSF 14-1					FOR NSF USE ONLY	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) EAR - SEDIMENTARY GEO & PALEOBIOLOGY					NSF PROPOSAL NUMBER	
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION	
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TITLE OF PROPOSED PROJECT Collaborative ICS-NSF Workshop: Vouchering the Stratigraphic Record						
REQUESTED AMOUNT \$ 0	PROPOSED DURATION (1-60 MONTHS) 12 months		REQUESTED STARTING DATE 02/01/15		SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE	
THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW <input type="checkbox"/> BEGINNING INVESTIGATOR (GPG I.G.2) <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e) <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d) <input type="checkbox"/> HISTORIC PLACES (GPG II.C.2.j) <input type="checkbox"/> VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____				<input type="checkbox"/> HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)		
<input checked="" type="checkbox"/> FUNDING MECHANISM Conference, Symposium, Workshop				<input checked="" type="checkbox"/> COLLABORATIVE STATUS Not a collaborative proposal		
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PROJECT SUMMARY

Overview:

Collaborative ICS-NSF Workshop: Vouchering the Stratigraphic Record

Stratigraphers have measured and sampled stratigraphic sections worldwide for 150 years. The information gained provided a wealth of evidence for reconstructing Earth's history and investigating its major events. Information continues to be gathered in ongoing investigations that involve a great diversity of often-integrated methods that allow for fundamentally new scientific questions to be addressed. Unfortunately, a most significant part of the wealth of information generated is not readily accessible to the current community of stratigraphers, and neither is much of the new data being gathered today. Instead, it is dispersed through a great range of publications and files, electronic and hardcopy, personal and public, worldwide. And much of the legacy data is lost from one generation of stratigraphers to the next. This loss seriously limits modern studies of the stratigraphic record and results in a science that is fragmented among various, diverse disciplines or methods, specialists and geographic regions. The solution is for the international community of stratigraphers to establish a publically accessible stratigraphic repository for all data generated in ongoing and future investigations worldwide and eventually to place legacy data in the repository. To initiate such an ambitious, long-term project requires considerable thought and planning. Accordingly, the proposed ICS-NSF Workshop: Vouchering the Stratigraphic Record is to bring together an international group of experienced stratigraphers representing the full range specialties in order to fully consider all important aspects of initiating this long term project.

Intellectual Merit :

Stratigraphy is a synthetic science, requiring the intimate integration of a broad array of subspecialties in developing a stratigraphic understanding and using that knowledge to address a great range of questions regarding the history of the Earth system. However, stratigraphic synthesis is complicated by the need to pyramid information from earlier generations to succeeding generations of stratigraphers. This needed pass off of generational information is seriously lacking because the information is widely scattered worldwide and not readily accessible.

Coordinating a unified approach to stratigraphy requires communication and integration between generations as well as between the scientific components of the science. From such an integrated approach emerges state of the art research and applied projects that promise to advance the frontiers in Earth science and reward us with societally and scientifically relevant results.

The coordinated archiving of relevant data for public-scientific access will 1) maximize the possibility of impactful groundbreaking research and meaningful applied results, 2) break through the generational information/data filter that has hobbled the science, and 3) unify the historical splintered nature of stratigraphy. The proposed workshop will allow this ambitious long-term project to be initiated.

Broader Impacts :

Vouchering the stratigraphic record would revolutionize the science of stratigraphy. As it is built, the database repository would become the primary source of stratigraphic knowledge for those considering investigations. Not only stratigraphers but also a variety of other geoscientists (e.g. structural geologists) would find the information valuable for their specific research. Furthermore, the database would be accessible to professors and teachers for classroom purposes and student research projects. Coordinating a unified approach to stratigraphy requires communication and integration between generations as well as between the scientific components of the science. Stratigraphy, as a science and as a community, must focus on new directions that integrate the science in meeting the challenges of the new century. This requires a more community driven integrated data storage campaign and public sharing and availability of such integrated data to provide the foundation upon which the future of stratigraphy depends.

The project would naturally foster extended international collaboration and cooperation.

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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Collaborative ICS-NSF Workshop: Vouchering the Stratigraphic Record

Introduction and Purpose

Stratigraphy is one of the classic disciplines of geology. The stratigraphic record provided the basis for the concept of “Deep Time”, was the foundation for the Geologic Time Scale, and revealed the often-dramatic events in the history of the Earth and life upon it. Stratigraphy is fundamental in the exploration and development of Earth’s energy and mineral resources, and it provides the historical basis for understanding the response of the Earth system to the current anthropogenic impact. Stratigraphers have rigorously measured and meticulously sampled stratigraphic sections for 150 years. Unfortunately, much of that information is not readily accessible. It is scattered worldwide through a great range of local, regional and national publications, in the files of public and private organizations, and in the personal records of a multitude of geologists. Little of it has been placed in computer based, publically accessible repositories. The time is now to initiate a program of vouchering (archiving) stratigraphic information as it is produced and to compile information gathered in the past. This will require importing stratigraphic information into one or more easily queried databases and standardizing methods of data acquisition and entry. Such a project is ambitious. It would be a major undertaking with no end station, but the effort must begin. In order to plan the initiation of this project, we propose a two-day workshop (July 24-25, 2015), following directly upon STRATI 2015 – 2nd International Congress on Stratigraphy that will be held in Graz, Austria, July 19-23, 2015. The workshop will be held in Graz, and it is expected that participants in the workshop will also participate in STRATI 2015. The goal of the workshop is to develop a plan of initiation for the project “Vouchering the Stratigraphic Record”. Factors that must be addressed include 1) the nature and location of the database to use, 2) standardization of data to be included, 3) the great variety of stratigraphic information to be entered, 4) steps to begin acquiring data to be entered in the database, 5) steps necessary to include the entire stratigraphic community in the project, and 6) the organizational structure. Support is requested for the costs of hotels and meals for 30 participants for two days and for airfare for ~20 of the participants, primarily those from the United States. Facilities in the Institute of Earth Sciences, University of Graz will be made available at no charge.

Statement of Need and Justification

Stratigraphy is a synthetic science, requiring the intimate integration of a broad array of subspecialties in developing a stratigraphic understanding and using that

knowledge to address a great range of questions regarding the history of the Earth system. Furthermore, discoveries of many exciting aspects of Earth's history derived directly from documentation of aspects of the stratigraphic record. Modern stratigraphic practice functions as a broad association of loosely linked, poorly coordinated, scientific subject areas (i.e., paleontology, geochronology, sedimentology, geochemistry, geophysics, paleoclimatology, paleoceanography, paleogeography, tectonics, geoinformatics, among others) covering the full gamut of deep time and sedimentary crust studies. Furthermore, stratigraphic synthesis is complicated by the need to pyramid information from earlier generations to succeeding generations of stratigraphers. This needed pass off of generational information is seriously lacking because the information is widely scattered worldwide through a great range of local, national, and international publications, has been stored as hard copy or non-public data files on outdated computer platforms or simply in the minds of practitioners and generally lost to later generations as stratigraphers retire or as active projects end. Coordinating a unified approach to stratigraphy requires communication and integration between generations as well as between the scientific components of the science. From such an integrated approach emerges state of the art research and applied projects that promise to advance the frontiers in Earth science and reward us with societally and scientifically relevant results. Without this integration, stratigraphy is splintered into subspecialties that individually may produce valuable, but less impactful results. Stratigraphy, as a science and as a community, must focus on new directions that integrate the science in meeting the challenges of the new century. This requires a more community driven integrated data storage campaign and public sharing and availability of such integrated data to provide the foundation upon which the future of stratigraphy depends.

To be fully successful and efficient, a historically based science, as is stratigraphy, needs a means of ensuring the generational pyramiding of stratigraphic information and documentation. The information gained from the sampling and documentation of stratigraphic sections must be vouchered (or archived) with the information then made publically accessible for modern stratigraphers and future practitioners of the science. The coordinated archiving of relevant data for public-scientific access will 1) maximize the possibility of impactful groundbreaking research and meaningful applied results, 2) break through the generational information/data filter that has hobbled the science, and 3) unify the historical splintered nature of stratigraphy.

The proposed NSF workshop, 'Vouchering the Stratigraphic Record' is a necessary first step. Experienced stratigraphers of all disciplines must consider the nature of the full gamut of stratigraphic information and data that can potentially be entered into a single database or linked databases, the extent to which data can be standardized, the database system to use, the initial data to enter, and the means of selling the project to the greater stratigraphic community worldwide. In its primary mission of establishing a single hierarchical set of global chronostratigraphic units (stages and the series and systems they comprise) with the boundary of each defined by a GSSP (Global Boundary Stratotype Section and Point), the International Commission on Stratigraphy working through its subcommissions has generated a

significant body of stratigraphic data from well studied stratigraphic sections worldwide for 50 years, is still generating such data and will continue to do so for at least 20 more years. Clearly the stratigraphic community must focus on issues with more pressing societal and human issues than those of formally defining the units of the International Chronostratigraphic Chart/Geologic Time Scale. Nevertheless, by requiring all data generated from measured sections in on-going and future investigations to be entered into a single, publically accessible database, ICS can naturally assume the lead role in the long-term project. The subcommissions of ICS currently include ~350 titular (voting) members from 40 countries worldwide. They are experienced stratigraphers, represent the full range of stratigraphic disciplines, and work cooperatively and collaboratively in the organization. Thus, ICS provides an invaluable organization and human resource for initiating the project.

Workshop Objectives

The workshop will address six objectives as listed below. It will be intense and focused over two days. After an overall introduction and agreement on the agenda, those knowledgeable on databases and standardization of data will describe the nature, process, possibilities, and difficulties of building large volume databases. In light of this information, the lithostratigraphers, biostratigraphers, chemostratigraphers, paleomagnetostatigraphers, sequence- and cyclostratigraphers, and geochronologists will, in turn, describe the nature of the data they collect and consider how it might be standardized. Leaders of various stratigraphic based databases (Geobiodiversity database, International Ocean Drilling Program, possibly others) will describe their experiences and the resources that might be available. The last day of the Workshop will be discussions among all participants. An identified database that can serve the initiation of the project must be approved by the participants. Methods for acquiring data and for encouraging the active support of the full stratigraphic community will be developed. If there is consensus support on moving forward . . . beyond the Workshop, an organizational structure will be established.

1. Nature and location of Database, its Management, and its Required Support.

The Geobiodiversity Database (GBDB) housed at the Nanjing Institute of Geology and Palaeontology is a key laboratory of the Chinese Academy of Sciences and is formally linked with the International Commission on Stratigraphy, serving as the primary archive of ICS generated data. This linkage was formally established in 2012. The GBDB was designed specifically for archiving measured sections and presently stores biostratigraphic data from more than 20,000 sections, as well as provides software for graphic and computational methods of synthesis and analysis. Should GBDB be the primary data repository for the project 'Vouchering the Stratigraphic Record'? Should other databases be considered? Should there be more

than one? How should the database be managed? How can it be funded adequately for the forthcoming decades? These are questions that must be addressed and resolved at the workshop.

2. The Nature of Stratigraphic Information to be entered into the Repository.

Obviously, all data gathered from measured stratigraphic sections should be entered. They can include geographic location including GPS locations of all sample and critical horizons, descriptions of lithologies, identifications of taxa from biostratigraphic samples, measurements from chemostratigraphic and magnetostratigraphic samples, calculated geochronologic ages of specific stratigraphic levels, digital images of the outcrop, and graphic representations of the exposure with all appropriate notations. Participants in the workshop must consider the specific nature of each and every type of possible observation and measurement in order to assess the nature of the database to be used.

3. Standardization of Data.

Most data from stratigraphic sections can easily be tied to precisely measured stratigraphic levels. These include lowest and highest occurrences of most fossil taxa and magnetic and chemical samples. Lithologic descriptions normally extend across stratigraphic intervals, and some types of fossils, e.g. ammonites, are collected from beds with significant stratigraphic thickness. How should these various types of stratigraphic information be entered into a database? To what extent can they or must they be standardized? Standard methods of data collection can be established for future studies, but how should non-standardized data collected in the past be handled?

4. Acquiring Data for the Repository – Initial Acquisition.

ICS can readily take the lead in acquiring data for the repository. As part of the approval and ratification process for GSSPs, it can require that data from the proposed stratotype section and all candidate stratotype sections be entered into the database before the GSSP proposal can be considered by ICS. Establishing this formal requirement must be discussed and approved by the ICS voting members (the executive officers and the chairs of the subcommissions). This approach and other possible approaches must be considered in the workshop.

5. Selling the Project to the greater Stratigraphic Community worldwide.

For the long-term success of the Project, stratigraphers worldwide and their affiliated organizations must be involved. Funding agencies that support their investigations must also be convinced that stratigraphic data generated be placed in the database. This requires professional contacts to be established between the organization of the Project, professional societies, governmental organizations, and foundations worldwide. Discussions at the workshop will focus on developing

contacts with the more important organizations, professional societies, and funding agencies.

6. Organizational Structure for the Project.

Plans must be developed for an organizational structure to initiate and manage the project. Initially this might be within ICS. Whether or not ICS should continue in that role, and how ICS might manage the project must be considered.

Workshop Participants

An ideal number of participants for the workshop is 25-30. It is critical that together their individual expertise includes biostratigraphy of various important groups of micro- and macrofossils, both carbonate and siliciclastic lithostratigraphy/sedimentology; chemostratigraphy, paleomagnetostratigraphy, cyclostratigraphy, sequence stratigraphy, and the complete geologic column (Archean to Holocene). In light of the global nature of the project that is the focus of the workshop, it is essential that the participants represent the international community of stratigraphers. Listed below are those who have been invited or will be invited. The list includes 38 participants of which 17 are from the United States.

Prof. Stanley Finney, California State University-Long Beach (Chair of ICS), organizer of workshop.

Dr. Kristin Lehnert, Lamont-Doherty Oceanographic Institution, specialist in standardizing data

Prof. Dena Smith, University of Colorado, STEPPE

Prof. Fan Junxuan, Nanjing Institute of Geology and Palaeontology, Director of Geobiodiversity Database

Prof. Isabel Monteñez, University of California, Davis, chemostratigraphy (strontium isotopes)

Prof. Matthew Salzmann, The Ohio State University, chemostratigraphy (carbon isotopes)

Prof. Peter Sadler, University of California, Riverside, CONOP creator, rates of sedimentation, quantitative stratigraphy

Prof. Shuang-ye Wu, University of Dayton, Ohio, quantitative stratigraphy

Prof. Qun Yang, Nanjing Institute of Geology and Palaeontology, Director of Institute

Prof. Xiangdong Wang, Nanjing Institute of Geology and Palaeontology,

Conodont specialist, Carboniferous System

Prof. Shuzhong Shen, Nanjing Institute of Geology and Palaeontology, Permian specialist on ammonids, fusulinids and conodonts.

Prof. Mike Melchin, St. Francis Xavier University, Canada, graptolite biostratigraphy, isotope stratigraphy, CONOP.

Prof. Andrew Miall, University of Toronto, Canada, sedimentation processes, rates, and discontinuities

Prof. Emertius Christopher Kendall, Univ. of South Carolina, carbonate sedimentation

Person to be named, IODP, person who oversees management of data from drill cores.

Prof. Martin Head, Brock University, Canada, Quaternary stratigraphy

Prof. Philip Gibbard, Cambridge University, UK, Quaternary stratigraphy

Prof. Dennis Kent, Rutgers University, paleomagnetostatigraphy

Prof. Paul Pearson, University of Cardiff, UK, planktonic foraminifera

Prof. Isabella Raffi, University of Chieti-Pescara, Italy, planktonic foraminifera

Prof. Paul Bown, University College London, UK, calcareous nannofossils

Prof. Simonetta Monechi, University of Florence, Italy, calcareous nannofossils

Prof. Bradley Sageman, Northwestern University, cyclostratigraphy, astronomical tuning

Luc Bulot, Aix-Marseille University, France, ammonite biostratigraphy

Prof. Jed Day, Illinois State University, conodont biostratigraphy, sequence stratigraphy

Prof. Carlton Brett, University of Cincinnati, sequence stratigraphy

Prof. David Harper, University of Durham, UK, brachiopod biostratigraphy

Prof. Thomas Servais, University of Lille, France, acritarch biostratigraphy

Prof. Loren Babcock, The Ohio State University, trilobite biostratigraphy

Prof. Brian Pratt, University of Saskatchewan, Canada, Cambrian biostratigraphy

Prof. Shuhai Xiao, Virginia Tech, Ediacaran stratigraphy

Prof. Alan Kaufman, University of Maryland, chemostratigraphy

Prof. Susannah Porter, University of California, Santa Barbara, Cryogenian stratigraphy

Prof. Helmut Weissert, ETH, Switzerland, chemostratigraphy, carbonate stratigraphy

Prof. Michael Joachimski, University of Erlangen, Germany, chemostratigraphy

Prof. Jacques Thierry, University of Bourgogne, France, Ammonite biostratigrapher

Prof. Giovanni Muttoni, University of Milan, Italy, paleomagnetostratigraphy

Dr. Lucy Edwards, U.S. Geological Survey, stratigrapher

Funding Request

Funds are requested to provide meals, lodging and facilities for all participants at the workshop, and for air travel to Graz, Austria primarily for American citizens. Participants who are not American citizens will be expected to receive travel support from their own countries, host institutions, or research grants. The costs in both categories is based on 25 participants.

1. Meals and meeting facilities for two days in Graz, Austria and lodging for three nights for 25 people. $\$509/\text{person} \times 25 \text{ persons} = \$12,725$
2. Varied, international air travel: 20 at \$1200 each and 5 at \$590 = \$26,950
3. Indirect Cost Rate (off-campus) for California State University at Long Beach $26\% \times \$39,675 = \$10,316$

Total: \$49,991