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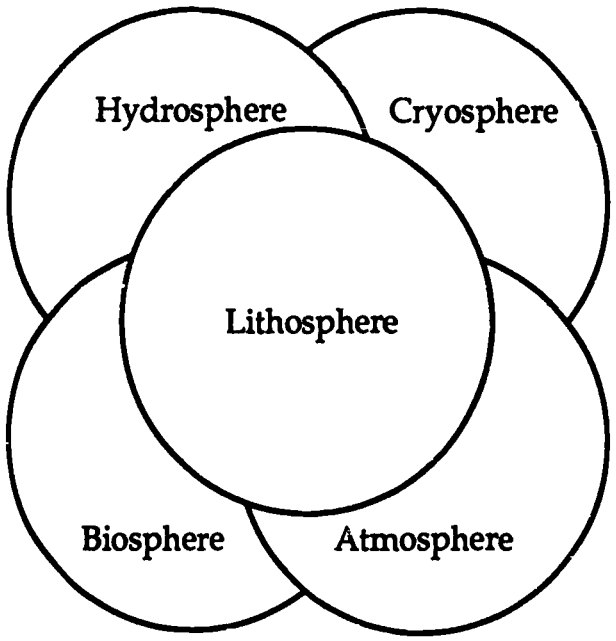
ABSTRACT

This meeting initiates the planning of new guidelines and a framework for teaching the earth sciences from kindergarten through grade 12. The conference report serves as a discussion paper for a series of American Geological Institute (AGI) regional conferences scheduled for fall and winter, 1988-89. It also provides background for an advisory board and steering committee that will assist AGI in publishing a curriculum planning guide tentatively titled "Kindergarten through Grade 12 Earth Science Education Framework for the 21st Century." Participating scientists in this conference were selected by their agencies on the basis of eminence in their fields, interest in a global approach to the study of Planet Earth, and interest in assisting in the planning of a new earth science education framework. Federal agencies included the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Science Foundation, and the U.S. Geological Survey. Included are the rationale for the conference, the goals of the meetings and the AGI education department's long range strategic plans. An outline of the goals and concepts for a 21st century view of Planet Earth is included. (MVL)

The American Geological Institute

Conference on EARTH SCIENCE EDUCATION for the 21st Century

April 19-23, 1988, Alexandria, Virgiria



EXECUTIVE SUMMARY

The American Geological Institute

Conference on EARTH SCIENCE EDUCATION for the 21st Century

April 19-23, 1988, Alexandria, Virginia

EXECUTIVE SUMMARY

INTRODUCTION

This meeting launches a revolution in earth science education. It initiates the planning of new guidelines – a Framework for teaching the earth sciences from Kindergarten through Grade 12. The conference report serves as a discussion paper for a series of American Geological Institute regional conferences scheduled for this fall and winter. It also provides background for an Advisory Board and Steering Committee that will assist AGI in publishing a curriculum planning guide tentatively titled, "Kindergarten Through Grade 12 Earth Science Education Framework for the 21st Century." This publication, scheduled for release before next summer, will include the basic concepts regarding Planet Earth that all students should know by the time they finish high school.

Participating scientists in this conference were selected by their agencies on the basis of eminence in their fields, interest in a global approach to the study of Planet Earth and interest in assisting in the planning of a new earth science education Framework.

Federal agencies included the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Science Foundation and the United States Geological Survey. Funding was provided by the Union Pacific Resources Company, the National Science Foundation Directorate for Science and Engineering Education and the National Science Foundation Directorate for Geosciences. Funding for teacher participants was provided by their local school districts. However, some teachers met their own expenses. Other science educators were supported by their universities and state education departments.

AGI Director of Education Mr. Andrew J. Verdon was conference Director, and Co-conveners of the conference were Drs. Ronald E. Armstrong of the South Glens Falls (New York) School District and Victor J. Mayer, Professor of Science Education and Geology of The Ohio State University, Columbus, Ohio.

RATIONALE FOR CONFERENCE

The outcomes of this conference are part of a continuum of activity initiated through a series of conferences sponsored by the American Geological Institute beginning in 1985. Participants of all conferences included members of the geoscience and science education communities. Classroom teachers have participated in all stages from planning through execution.

The report of this conference and other conferences held throughout the nation during 1988 will provide information for synthesis, analysis and development of a Kindergarten through Grade 12 Earth Science Education Framework to be published by the American Geological Institute in 1989 (see diagram).

The information contained in this report and ensuing reports during the Framework development process will provide guidance to curriculum developers at all levels as to the nature of earth science instruction for the 21st Century.

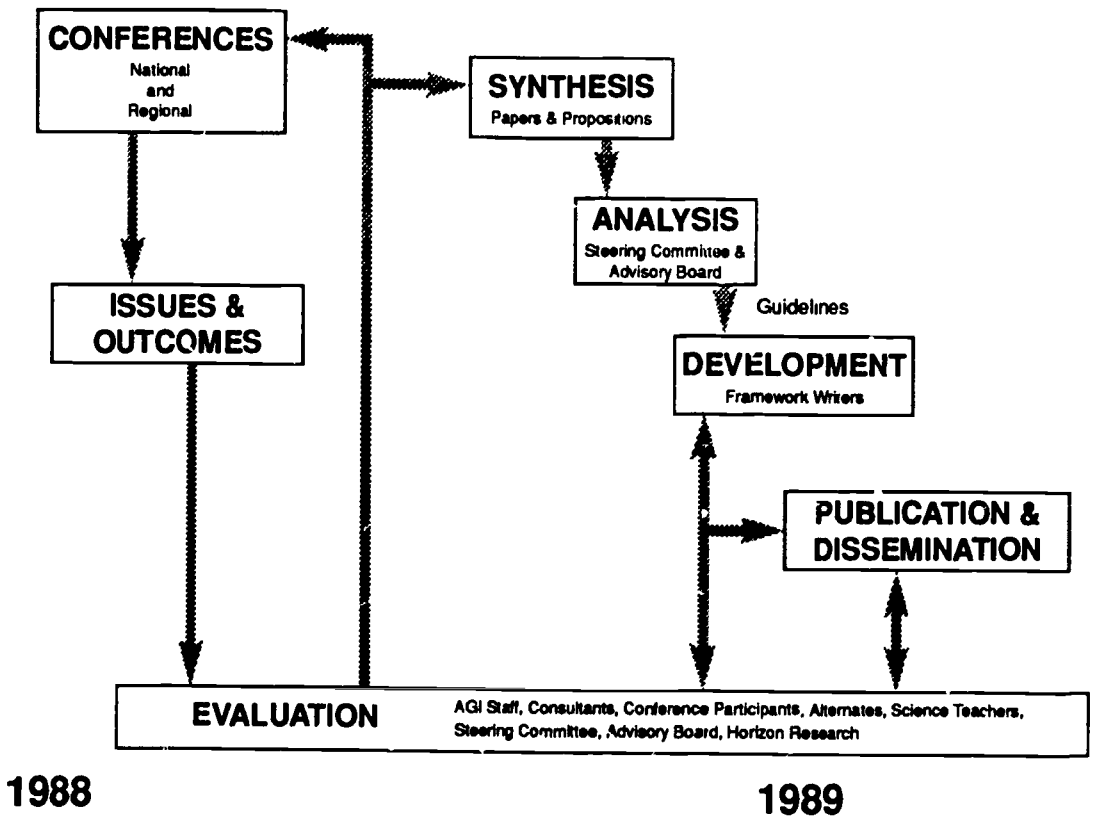
In addition to providing guidance to curriculum developers, these reports and Framework will provide guidance for all programs in the areas of research in teaching and learning as well as in human resources, i.e., teacher preparation and enhancement, and training of other personnel, including students, guidance counselors, building principals, science supervisors, parents, and school boards.

These reports and Framework will also encourage new initiatives for the development of partnerships among the geoscience community, classroom teachers, and the science education community. This network of individuals and agencies will include geoscience research organizations in the public and private sector and professional societies.

Several themes emerge that will affect the nature of science education for the 21st century. These include

- the need for a general understanding of the balance between exploration and extraction of Earth resources to advance civilization and awareness of human effects and dependence on dynamic and fragile Earth processes.
- that a study of Earth is multidisciplinary and can be integrated with other subject areas.
- that a study of Earth is for all students, should begin at the elementary level, and continue through the secondary level. This will ensure that our nation's population will be able to make informed personal and civic decisions concerning environmental, earth hazards, energy, water and other pressing issues. It will also attract students to the study of, and careers in, the geosciences.

K–12 EARTH SCIENCE EDUCATION FRAMEWORK



- that a sense of Stewardship and Appreciation of the Earth be conveyed throughout the learning process along with the Knowledge and Methodology of the Earth sciences.
- that this Methodology varies. In addition to the experimental/quantitative approach to scientific investigation, an equally important historical/descriptive approach is employed.
- that the study of the Earth conveys a sense of Evolution – of the Solar System and of Life. It provides the context for an understanding of such key principles as Deep Time, Scale, and Cycles.

This report, along with the Framework, must be perceived within the context of broad issues affecting science education, including among others the concept of the competitiveness of the United States within the geopolitical sphere and in the world market, and the attitudes of Americans (parents, students, the community) towards education compared to other industrialized nations.

1988 REGIONAL CONFERENCES ON EARTH SCIENCE EDUCATION

The report of this conference serves as a basis for continuing discussion to publish guidelines for earth science instruction from Kindergarten through Grade 12. To further this objective and to meet the goals listed below, a series of regional meetings is being conducted during the Fall and Winter of 1988. The purpose of the regional meetings is to bring about a consensus in the geoscience community for appropriate geoscience course content for grades K-12 and for implementing plans to improve earth science education at the regional level.

The goals of the series of regional meetings include

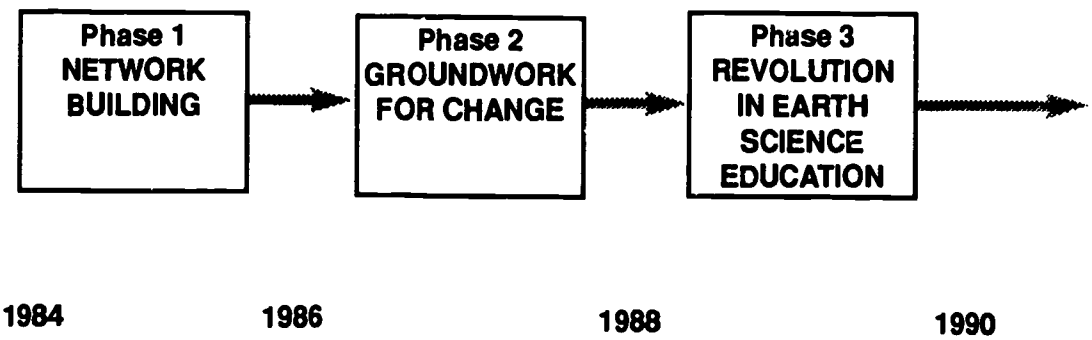
- to provide the opportunity for geoscientists in industry, academia and government to interact with teachers and other science educators in their region
- to provide participants the opportunity to convey their insights toward the publication of an earth science education Framework for Kindergarten through Grade 12
- to provide participants the opportunity to react to presentations made by key speakers concerning the status of earth science education at the national, regional and local levels
- to provide interested participants the opportunity to serve on planning teams to develop tactics to improve the teaching of earth science at the regional and local levels
- to seek potential applicants for a program to identify and select key individuals to work with the AGI National Center for Earth Science Education

Reports from all conferences will be utilized in the production of the K-12 earth science education Framework.

These conferences mark the continuation of a process set in motion by AGI's 1985, 1986, and 1987 NSF-supported conferences, which set priorities for developing our current initiatives in earth science education.

AGI EDUCATION DEPARTMENT LONG RANGE STRATEGIC PLAN

Through its National Center for Earth Science Education, the American Geological Institute is initiating the third phase of a long range strategic plan. This plan was set in motion in 1984, by sponsoring a series of conferences of scientists and science educators to define and synthesize the information that is now known about Planet Earth and its environmental setting in space. Further objectives include the ultimate preparation of these materials in the form of a Framework for K-12 curricula which will address such areas as how these materials can be used by publishers, state science supervisors, and other curriculum specialists; what information every 17-year-old should know about Planet Earth; and what additional materials should be available for those science-oriented students.



1984 - 1986 Phase I – Network Building
developed working relationships with key leaders in the science education community to draw national attention to earth science education.

1986 - 1988 Phase 2 – Groundwork for Change
initiated several recommendations from AGI/NSF conferences including the production of a national earth science examination, a teacher internship program, and creating a National Center for Earth Science Education.

1988 - 1990 Phase 3 – Revolution in Earth Science Education
calls for the building of a consensus in the geoscience and science education communities for a new set of guidelines (Framework) for earth science education from Kindergarten through Grade 12 (K-12).

CONFERENCE AGENDA

Radisson Mark Plaza Hotel, Alexandria, VA

Tuesday, April 19

8:00 a.m.	Welcoming and Introductions – Poplar Room Dr. Ron Armstrong – Conference Co-convener Dr. Marvin E. Kauffman – AGI Executive Director Mr. Andrew J. Verdon, Jr. – AGI Director of Education Dr. Victor J. Mayer – Conference Co-convener
9:00	Dr. James Rutherford, Chief Education Officer, American Association for the Advancement of Science: *Perspectives on Science Curriculum*
10:00	Coffee and Tea – Poplar Room
10:30	Small group sessions of 4 scientist/educator teams. Scientists will each present a paper on scientific understandings from their disciplines that they believe all graduating high school students should know about Planet Earth, followed by group discussion. – Poplar Room, Rooms 2609, 2615, and 2904
12:30 p.m.	Lunch and discussion of scientist/educator teams
2:00	Small group session to identify the understandings from the earth science disciplines needed by all high school graduates – Poplar Room, Rooms 2609, 2615, and 2904
4:00	Refreshments – Poplar Room
4:30	Large group session – Presentations by Dr. Robert Heller, Chairman of the AGI Foundation and Payson Stevens, Internetwork, Inc. – Poplar Room
8:00	Reception, Cash Bar – Walnut Room

Wednesday, April 20

8:30 a.m.	Large group session – Poplar Room
9:00	Dr. Audrey B. Champagne, American Association for the Advancement of Science: *Misconceptions in Learning Science*
10:00	Coffee and Tea – Poplar Room
11:00	Small group sessions – Poplar Room, Rooms 2609, 2615, and 2904
12:30 p.m.	Lunch and scientist/educator team discussions
2:00	Small group sessions continue
4:00	Refreshments – Poplar Room
4:30	Large group session – Ms. Monica Bradsher and Ms. Dorothy Perreca, National Geographic Society, *Kid-Net*; J. Julius Dasch, Oregon State University, *Pizza Geology* – Poplar Room

Thursday, April 21

8:30 a.m.	Large group session – Poplar Room
9:00	Speaker: Dr. Dallas Peck, Director, U. S. Geological Survey
10:00	Coffee and Tea – Poplar Room
10:30	Revised small group sessions – 4 educator/scientist teams; identify earth science understandings needed by all high school graduates – Poplar Room, and Rooms 3609, 2615, and 2904
12:30 p.m.	Lunch and scientist/educator team discussions
2:00	Continuation of morning small group session topic
4:00	Refreshments – Poplar Room
4:30	Large group session – Dr. Fred Finley, *Misconceptions in Earth Science*; Dr. Susan Humphris, SEA Education Programs – Poplar Room
7:30	Banquet – Walnut Room

Friday, April 22

8:30 a.m.	Large group session – Ms. Marilyn Suiter, AGI, *Women and Minorities in Science*; Dr. Victor J. Mayer, *The Development of this Conference* – Poplar Room
9:15	Coffee and Tea – Poplar Room
9:45	Small group sessions – Poplar Room and Rooms 2609, 2615, and 2904
12:00 p.m.	Lunch
1:30	Large group session – integration of the small group reports into single consensus document – Poplar Room
3:30	Refreshments – Poplar Room
4:00	Frank Ireton, AGI Teacher Intern, demonstration of ESEENET Telecommunications – Poplar Room
4:30	Closing

Saturday, April 23

8:45 a.m.	Transportation to AGI – Radisson Main Entrance
9:00	Educator Session – Heroy Conference Room, AGI Headquarters
12:00 noon	Lunch

SUMMARY

1.0 PREAMBLE

This summary outlines the goals and concepts that are a prerequisite for an evolving 21st century view of Planet Earth. In addition to these goals and concepts we believe the following elements are important:

1.1 The study of Planet Earth must begin in the elementary school, K-6, and continue at the secondary level, 7-12.

1.2 The study of Planet Earth must include a hands-on, investigative approach.

1.3 The inclusion of women and minorities throughout the study process should be emphasized.

1.4 The study of Planet Earth should be integrated with other disciplines including geography.

1.5 Mathematics, computer technology and other emerging technologies should be incorporated in the study.

1.6 A case study approach regarding societal issues should be used in any study of Planet Earth.

1.7 Parents and the community should be included in parts of the study.

1.8 Capture the excitement and fun of learning about Planet Earth.

2.0 GOALS

Study of the Planet Earth is important for all students. As members of present and future societies students should be able to

2.1 understand the nature of scientific inquiry using the historical, descriptive and experimental methods of the Earth sciences. **Scientific Thought**

2.2 understand Earth processes and features and anticipate changes in them. **Knowledge**

2.3 respond in an informed way to environmental and resource issues. **Stewardship**

2.4 develop an aesthetic appreciation of the Earth. **Appreciation**

3.0 CONCEPTS

3.1 The Earth system is a small part of a solar system within a vast universe.

3.2 Earth system is comprised of interacting subsystems (the hydrosphere – water; the lithosphere – sediments and rocks; the atmosphere – air; the biosphere – life; the cryosphere – ice.)

3.3 The Earth's subsystems (land, water, frozen water, air and life) are continuously changing, evolving and interacting through natural processes and cycles.

3.4 The Earth's natural processes take place over periods of time from fractions of seconds to billions of years.

3.5 Many of the resources of the Earth's subsystems are limited and vulnerable to overuse, misuse, or change resulting from human activity.

3.6 A better understanding of the Earth system and its subsystems stimulates greater aesthetic appreciation.

3.7 The development of technology has increased and will continue to increase our ability to understand the Earth.

3.8 Earth scientists are people who study the origin, materials, history, structure, processes, and evolution of Earth's subsystems. They use their specialized knowledge to describe subsystems, identify and evaluate resources and predict the likelihood and impact of future events.

CONCEPT 3.1

3.1 The Earth system is a small part of a solar system within a vast universe.

- 3.1.1 All bodies in space (including Earth) are influenced by processes acting throughout the solar system and the universe.
- 3.1.2 The sun is one of billions of stars in the universe.
- 3.1.3 The sun is the primary source of Earth's energy.
- 3.1.4 The nature of each planet in our solar system is determined by its position in the solar system and by its mass.
- 3.1.5 The position and motion of Earth with respect to the sun and moon influence tides, seasons and climates.

CONCEPT 3.2

3.2 The Earth is comprised of interacting subsystems (the hydrosphere – water; the lithosphere – sediments and rocks; the atmosphere – air; the biosphere - life; the cryosphere – ice.)

3.2.1 Water exists as a vapor, as a liquid and as a solid and changes form as a result of changes in energy.

3.2.2 Water in the oceans is in constant motion and covers more than 70% of the planet.

3.2.3 The cryosphere (frozen water) is an Earth subsystem that has varying seasonal and global distribution.

3.2.4 Atmospheric circulation is driven by solar heating and modified by interactions with the other subsystems.

3.2.5 The outer layers of the Earth (lithosphere, asthenosphere) interact with the hydrosphere, atmosphere, cryosphere and biosphere which are also interactive among themselves.

3.2.6 Geothermal and solar energy influence the dynamics of the Earth system.

3.2.7 The various components of the Earth system have characteristic properties, structures and compositions.

CONCEPT 3.3

3.3. The Earth's subsystems (water, land, ice, air and life) are changing, evolving and interacting through natural processes and cycles.

3.3.1 The major cycles are: the hydrologic cycle, rock cycle, plate tectonic cycle, carbon, cycle, trophic cycle.

3.3.2 Water changes from vapor to water to ice, and moves from the ocean to the atmosphere to the land and back again. (*Hydrologic Cycle*)

3.3.3 Rocks change and reform by erosion and deposition, heat and pressure, and melting. (*Rock Cycle*)

3.3.4 The outer part of the solid Earth is composed of plates which form in certain places from molten rock, move, and descend back into the Earth where they are remelted. (*Plate Tectonic Cycle*)

3.3.5 The element Carbon moves from rocks to water to air to life and back to rocks. (*Carbon Cycle*)

3.3.6 Energy from the sun and inorganic elements are transferred from plants to animals and back again. (*Trophic Cycle*). Note: Atmospheric cycles need to be included!

CONCEPT 3.4

3.4 The Earth's natural processes take place over periods of time from fractions of seconds to billion of years.

3.4.1 Physical processes in the universe range over scales of fractions of seconds to billions of years and over very great distances.

3.4.2 Earth is more than 4.5 billion years old and continually evolving.

3.4.3 The atmosphere, a thin, protective blanket composed of various gases and other substances that have evolved through time, is more than 4 billion years old.

3.4.4 The biosphere, which is more than 3.5 billion years old, has evolved interactively from relatively simple to relatively complex forms.

3.4.5 The hydrosphere, which is over 4 billion years old has evolved through additions from the interior and the surface of the Earth.

3.4.6 Evolution results in a sequence of unique historical changes of Earth's subsystems, for example:

3.4.6.1 changes in atmospheric composition

3.4.6.2 changes in life forms

3.4.6.3 changes in structure of the solid Earth

3.4.6.4 changes in the composition of the hydrosphere

CONCEPT 3.5

3.5 Many of the resources of the Earth's subsystems are limited and vulnerable to overuse, misuse, or change resulting from human activity. These resources include

3.5.1 fossil fuels

3.5.2 minerals

3.5.3 fresh water

3.5.4 soils

3.5.5 flora and fauna

3.5.6 atmosphere

3.5.7 oceans and rivers

CONCEPT 3.6

3.6 A better understanding of the Earth's subsystems stimulates greater aesthetic appreciation of the Earth.

- 3.6.1 Humans appreciate and manage the Earth by preservation, appropriate utilization and restoration, for example
  - 3.6.1.1 development of parks
  - 3.6.1.2 reclamation
  - 3.6.1.3 conservation
  - 3.6.1.4 recreation
  - 3.6.1.5 legislation
  - 3.6.1.6 land management and planning
  - 3.6.1.7 governmental and public cooperation from local to international levels
  - 3.6.1.8 other resource management (i. e., recycling)

CONCEPT 3.7

3.7 The development of technology has increased, and will continue to increase our ability to understand the Earth. The use of

- 3.7.1 optical and electron microscopes
- 3.7.2 optical and radio telescopes
- 3.7.3 infrared sensing
- 3.7.4 Doppler radar
- 3.7.5 submersibles and other oceanographic research vessels
- 3.7.6 satellites
- 3.7.7 computers
- 3.7.8 and other instruments and equipment has greatly increased our understanding of the Earth and its environment in space.

CONCEPT 3.8

3.8 Earth scientists are people who study the origin, materials, processes, and evolution of the Earth's subsystems.

3.8.1 They use their specialized knowledge to identify resources and predict the likelihood and the impact of future events.

3.8.2 They use a variety of scientific methods to study the Earth.

3.8.3 They use a variety of technologies to study the Earth.

3.8.4 They use oral, written and electronic means of communicating to promote the advancement of their research.

3.8.5 Most earth scientists belong to one or more professional societies which conduct annual and regional meetings and which publish a variety of journals, bulletins, reports and newsletters.

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ACKNOWLEDGEMENTS

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In particular we wish to thank all those listed for their assistance in planning, convening, addressing, and participating in the variety of chores necessary for the successful completion of such a conference. Organizations instrumental in supporting this work include the American Association for the Advancement of Science, the National Association of Geology Teachers, the National Earth Science Teachers Association, the National Science Teachers Association, and the Directorates for Science and Engineering Education and Geoscience of the National Science Foundation.

Professor Victor J. Mayer of Ohio State University and Dr. Ronald Armstrong of South Glens Falls School District deserve special recognition for their outstanding work as co-conveners for the Conference.

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