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The "Anthropocene" epoch: Scientific decision or political statement?

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Featured Articles

SCIENCE

Cover: Prof. Axel von Hillebrant (Technical University, Berlin) driving the golden spike into the bed that marks the base of the Jurassic System (Lower Jurassic Series; Hettangian Stage), 20 August 2011. Prof. von Hillebrandt led the team that investigated the Kuhjoch section in the Northern Calcareous Alps of western Austria, where the GSSP is located, and prepared the GSSP proposal, which was subsequently approved by ICS and ratified by IUGS. See related article, p. 4–10.

GROUNDWORK

GSA News

The "Anthropocene" epoch: Scientific decision or political statement?

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ABSTRACT

The proposal for the "Anthropocene" epoch as a formal unit of the geologic time scale has received extensive attention in scientific and public media. However, most articles on the Anthropocene misrepresent the nature of the units of the International Chronostratigraphic Chart, which is produced by the International Commission on Stratigraphy (ICS) and serves as the basis for the geologic time scale. The stratigraphic record of the Anthropocene is minimal, especially with its recently proposed beginning in 1945; it is that of a human lifespan, and that definition relegates considerable anthropogenic change to a "pre-Anthropocene." The utility of the Anthropocene requires careful consideration by its various potential users. Its concept is fundamentally different from the chronostratigraphic units that are established by ICS in that the documentation and study of the human impact on the Earth system are based more on direct human observation than on a stratigraphic record. The drive to officially recognize the Anthropocene may, in fact, be political rather than scientific.

INTRODUCTION

Since the publication in *GSA Today* of the article titled, "Are we now living in the Anthropocene?" (Zalasiewicz et al., 2008), the proposal that a new epoch in the geologic time scale called the "Anthropocene" be established has received greatly increasing attention in both scientific and public media (e.g., *Nature*, *Scientific American*, *Science*, *Geoscientist*, *The New York Times*, *Los Angeles Times*, *The Economist*, *National Geographic*, *Der Spiegel* online, to name a few). This attention arises from the desire by some for official recognition of the impact of humans on the Earth system, specifically its surface environments. A 2011 editorial in *Nature* asked, "Geologists are used to dealing with heavy subjects, so who better to decide on one of the more profound debates of the time: does human impact on the planet deserve to be officially recognized? Are we living in a new geological epoch—the Anthropocene?" The editorial answered the questions as follows:

> *Official recognition of the concept would invite cross-disciplinary science. And it would encourage a mindset that will be important not only to fully understand the transformation now occurring but to take action to control it. … Humans may yet ensure that these early years of the Anthropocene are a geological glitch and not just a prelude to a far more severe disruption. But the first step is to recognize, as the term Anthropocene invites us to do, that we are in the driver's seat. (Nature, 2011, p. 254)*

That editorial, as with most articles on the Anthropocene, did not consider the mission of the International Commission on Stratigraphy (ICS), nor did it present an understanding of the nature of the units of the International Chronostratigraphic Chart on which the units of the geologic time scale are based. We take this opportunity to provide the greater geoscience community with an understanding of the charge of the ICS and an appreciation of the history and nature of the units of the International Chronostratigraphic Chart. We compare the concept of Anthropocene to that of the systems, series, and stages of the International Chronostratigraphic Chart. We examine its usefulness as a unit defined by the criteria in the *International Stratigraphic Guide* (http://www.stratigraphy.org/index.php/ics-stratigraphicguide). We address the question of whether or not the International Commission on Stratigraphy is being asked to make what is in effect a political statement.

THE ICS AND THE INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

The ICS, the largest constituent scientific body in the International Union of Geological Sciences (IUGS), is composed of a three-person executive board and 16 subcommissions, each with ~20 voting members, who together represent more than 50 countries. Its charge is to define a single hierarchal set of global chronostratigraphic units with precisely defined boundaries that can be correlated as widely as possible. Boundaries are selected at levels that best set limits to the chronostratigraphic unit that they delimit, and boundary definition employs the concept of Global Standard Stratotype Section and Point (GSSP) as set out in the *International Stratigraphic Guide* (Salvador, 1994) and in revised ICS guidelines (Remane et al., 1996). The web-based archive of the chronostratigraphic units and GSSPs approved by ICS and

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*Chair, International Commission on Stratigraphy

**Commissioner, North American Commission on Stratigraphic Nomenclature

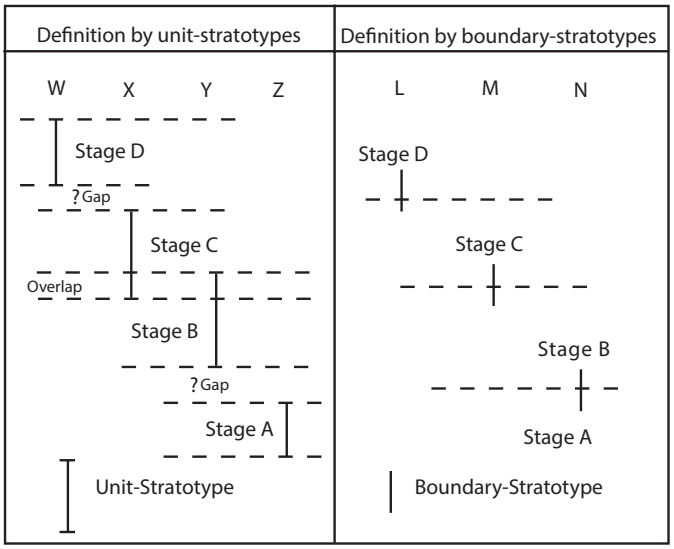

Figure 1. Advantage of defining chronostratigraphic units (stages) by lower boundary-stratotypes rather than by unit-stratotypes. Under boundary-stratotypes a specific level (horizontal dashed line) within a stratotype section (solid vertical line) serves to define the base of the superjacent unit and the top of the subjacent unit. Capital letters refer to widely separated type localities. Modified from Salvador (1994, their fig. 14).

ratified by IUGS is the ICS International Chronostratigraphic Chart and the Table of GSSPs, which are linked to the publications of the ratified GSSP proposals (www.stratigraphy.org).

Most of the systems, series, and stages of the ICS International Chronostratigraphic Chart were first defined from type sections or type areas in Europe, and they served as the basis for temporally correlating stratified Phanerozoic rocks worldwide primarily on their paleontological content. Although the traditional chronostratigraphic units were initially characterized by and correlated on the biostratigraphy of macrofossils, the biostratigraphy of microfossils became more widely used because they offered higher resolution and more widespread correlation. More recently, records of magnetostratigraphy, chemostratigraphy, cyclostratigraphy, and sequence stratigraphy have been established for most units, thus adding more varied and global stratigraphic signals for correlation. Thus, the concept of chronostratigraphic units today is a composite of stratigraphic information from successions worldwide.

When the traditional units were first named, boundaries between successive units were rarely defined. In fact, many units in type areas are bounded above or below by unconformities or covered intervals, and type areas of successive units are often at different locations. With continued study in type areas, with the study of stratigraphic successions elsewhere, and with the increased resolution of long-distance correlation, many successive chronostratigraphic units were discovered to either overlap or to be separated by gaps (Fig. 1). Furthermore, because of paleoecological and paleogeographical limits to the fossil content on which the units were recognized and because of the lack of specific boundaries, different interpretations of the stratigraphic extent and status were accorded to the same unit from one region to another, and multiple sets of regional series and stages were established for many systems (e.g., Webby, 1998). These deficiencies complicated stratigraphic nomenclature and hindered communication.

Since the time of Nicolas Steno, those who observed stratified rocks and considered the processes by which they formed accepted the concept that stratigraphic successions recorded the passage of time. Present-day bodies of strata are distinguished from the interval of time in the past when they accumulated as sediment by the use of two sets of terms. Chronostratigraphic terms apply to rock units (system, series, and stage), and geochronologic terms apply to time units (period, epoch, and age). These differences in terminology and concepts are presented in all stratigraphic guides and codes, even in first-year historical geology textbooks, and date to the 2nd International Geologic Congress in Bologna in 1881 (Vai, 2004).

A GSSP defines a stratigraphic boundary between two successive chronostratigraphic units in a single, continuous stratigraphic section. It sets the lower limit to the content of stratigraphic signals in a designated unit; hence, the upper limit to the content of the subjacent unit. The detailed succession of stratigraphic signals through the boundary interval is the basis for interpreting the correlation of that boundary into successions at other localities. The correlation of boundaries between successions in different localities is no different from correlating various stratigraphic levels or intervals within a unit, except that a GSSP is preferably placed at a stratigraphic level that provides the best set of stratigraphic signals for worldwide correlation. Use of lower-boundary GSSPs results in a succession of units between which there are no gaps and no overlaps (Fig. 1). A proposal for a GSSP is evaluated on several criteria (Remane et al., 1996), with the most important being that the boundary interval in the stratotype section has a diversity of stratigraphic signals that serve as the reference for the most reliable long distance correlation possible.

Since the first GSSP was ratified in 1972 for the boundary between the Silurian and Devonian systems, 62 of the 100 boundary levels that define the stages, series, and systems of the ICS Chart (download from www.stratigraphy.org) have ratified GSSPs. Most often, these sites are marked with an explanatory panel, a formal plaque (Fig. 2), and a "golden spike" (Fig. 3).

Figure 2. Plaque that marks the Global Standard Stratotype Section and Point (GSSP) for the base of the Thanetian Stage (Paleocene Series, Paleogene System) at Zumaia, the Basque Region, Spain.

Figure 3. Top of golden spike emplaced in bed that is the Global Standard Stratotype Section and Point (GSSP) for the Thanetian Stage. Length of "rock hammer" is 5 cm.

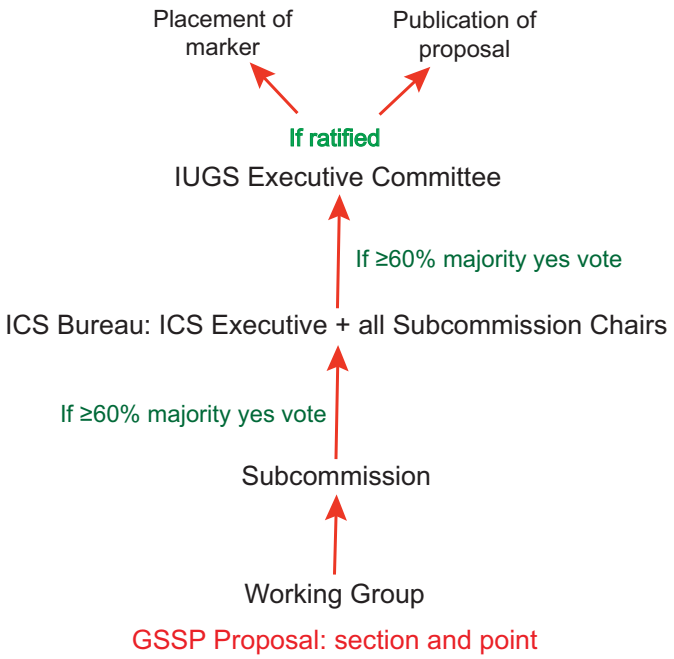

Figure 4. Workflow for approval and ratification of a Global Standard Stratotype Section and Point (GSSP) proposal. Extensive discussion and evaluation occurs at the level of the working group, subcommission, and International Commission on Stratigraphy (ICS) Bureau. If approved at these successive levels, a proposal is forwarded to the International Union of Geological Sciences (IUGS) for ratification. This process is also followed for other ICS decisions on standardization, such as approval of names of formal units, of revisions to the units, and to revision or replacement of GSSPs.

They are regarded as international geostandards, and their protection and future scientific study are encouraged. Each one serves as the primary definition of a boundary, which is the succession of stratigraphic signals in a boundary interval and the single signal at the stratigraphic level at which the boundary is placed. Locating the boundary in stratigraphic successions elsewhere is an interpretation made to the standard reference, the GSSP, after evaluation of all stratigraphic signals. The formal process of ratification of a GSSP (Fig. 4) begins with preparation of a written proposal by a working group comprised of specialists on the boundary interval. Development of a formal proposal requires extensive investigations of candidate stratotype sections and boundary levels worldwide. Following consensus approval of a proposal by the working group, it is then considered by the voting members of the relevant ICS subcommission. If approved by the subcommission, the proposal is forwarded to the ICS executive for consideration and voting by the ICS executive and the chairs of the 16 subcommissions. If approved at this level, the proposal is forwarded to the IUGS Executive Committee for ratification. Following ratification, the GSSP proposal must be published and posted on the ICS website, and the GSSP must be marked. The rigorous criteria on which a GSSP proposal is evaluated and the several levels of evaluation and consideration by which it is approved and ratified give validity and authority to ratified GSSPs as international geostandards.

A geochronologic unit (period, epoch, age) is the time interval during which the strata of a chronostratigraphic unit accumulated (Salvador, 1994). Geologic and biologic events and settings of the past, recorded in and interpreted from the rock record, are expressed in terms of geochronologic units. Once two successive GSSPs have been ratified, all the rocks that can be correlated to levels between the GSSPs are the stratigraphic record from which past events in Earth's history are interpreted for that interval of time. Geochronologic terms yield a relative geologic time scale, and calibrated ages make up a numerical geologic time scale. Calibrated numerical ages do not define the boundaries; they are subject to refinement and recalibration. It is the GSSP, a specific stratigraphic level in a stratotype section, that defines the boundary and to which numerical ages are calibrated to varying degrees of certainty.

THE ANTHROPOCENE

The term Anthropocene is widely used. In its latest iteration, it refers to the present, when human impact on Earth's surface, atmosphere, and hydrosphere has been deemed to be global. International organizations; national, regional, and local governments; nongovernmental organizations; and industries have taken steps to mitigate and remediate the impact where its nature is judged to be deleterious. Nevertheless, human impact is immense and potentially increasing. But, the question is: Should the Anthropocene be approved by the ICS and ratified by the IUGS as an official unit of the ICS International Chronostratigraphic Chart?

STRATIGRAPHIC RECORD OF THE ANTHROPOCENE

In contrast to all other units of the ICS chart, the concept of the Anthropocene did not derive from the stratigraphic record. It arose with Paul Crutzen (2002), a Nobel Laureate in Chemistry, who suggested that because of a greatly increased human impact on the Earth system, we had entered a new epoch, for which he proposed the term Anthropocene. Zalasiewicz et al. (2008) considered the effects referred to by Crutzen and raised the question of whether the effects justified the need for a new term, and if so, where and how its boundary might be placed. The ICS Subcommission on Quaternary Stratigraphy established a

working group in 2009 to consider these questions. Since then, discussion of the Anthropocene has been extensive, with articles in both scientific publications and the public media, as well as in the greater academic sphere, including the social sciences and the legal community.

Summaries of anthropogenic changes to the Earth system and their occurrence in the stratigraphic record can be found in Zalasiewicz et al. (2008, 2011) and Waters et al. (2014a, 2014b). That stratigraphic record is negligible (Walker et al., 2015), especially with a boundary set at 1945, as recently proposed by the Anthropocene working group (Zalasiewicz et al., 2015). Most of the stratigraphic records mentioned are potential records that might appear in the future; they are based on predictions. Human structures, excavations, boreholes, bioturbation of soils (agriculture) and the sea floor (drag net fishing) are not strata. Made ground, refuse piles, mine dumps, and leach pads are made by humans rather than by natural sedimentation. The strata with records of anthropogenic change are speleothems, ice cores, and non-lithified sediments of rivers, marshes, lakes, coasts, and the ocean floor. In most of these depositional settings, it would be difficult to distinguish the upper few centimeters of sediment from the underlying Holocene, or sediment that has accumulated versus that that is in transit. Published logs with geochemical signatures of human impact are at most a few tens of centimeters thick (Nozaki et al., 1978; Al-Rousan et al., 2004; Marshall et al., 2007). Locating a boundary at 1945 would be difficult for anthropogenic isotope shifts in greenhouse gases that have been rising for 100 years or more (Wolff, 2014).

DEFINING THE ANTHROPOCENE BY ITS BASE (GSSP) OR BEGINNING (GSSA)

The Anthropocene working group has focused on defining the base or beginning of the Anthropocene, and several recent proposals have been published (e.g., Lewis and Maslin, 2015). That of Zalasiewicz et al. (2015), co-authored with 25 other members of the Anthropocene working group, sets a GSSA (Global Standard Stratigraphic Age) for the Anthropocene as 1945, the year of the first nuclear bomb explosion. Regrettably, focusing on the definition of the beginning of the Anthropocene can result in the lack of consideration of its stratigraphic content and its concept. It conveys the opinion that units of the geologic time scale are defined solely by their beginnings, rather than their content.

Zalasiewicz et al. (2004, p. 1) argued that the distinction between chronostratigraphic and geochronologic units is no longer necessary because of the widespread adoption of GSSPs "in defining intervals of geologic time within rock strata." Because GSSPs are placed at stratigraphic horizons that also represent specific points in time, two successive GSSPs define an interval of time that is a geochronologic unit (period, epoch, age), and all strata interpreted as deposited during that interval of time would comprise the corresponding chronostratigraphic unit (system, series, stage). The difference between this concept and that espoused in the *International Stratigraphic Guide* (Salvador, 1994)—that chronostratigraphic units and their boundaries serve to define corresponding geochronologic units—is subtle, yet important. It is stratigraphic content that allows for the recognition and correlation of a chronostratigraphic unit. Most correlations are made within units and not to their boundaries. The GSSP serves to set a limit on the stratigraphic content of a unit; it defines a boundary, not a unit. Formal systems, series, and stages have been recognized since 1881, yet the first GSSP was not ratified until 1972. Obviously, chronostratigraphic units and their corresponding geochronologic units were used long before there were GSSPs. The *International Stratigraphic Guide* (Salvador, 1994) provides specific criteria for definition of chronostratigraphic units, but it provides no guidelines whatsoever for defining geochronologic units other than the intervals of time represented by the corresponding chronostratigraphic units. Furthermore, the guide discusses GSSPs only with regard to defining boundaries of chronostratigraphic units and not to defining beginnings or ends of geochronologic units. For these reasons, the concept and definition of chronostratigraphic units of Zalasiewicz et al. (2004), which are further presented in Zalasiewicz et al. (2008, 2011, 2015), are not consistent with the history of these units nor with the *International Stratigraphic Guide*.

The lower boundary of the Cretaceous System is not yet defined by a GSSP, and neither are the Lower Cretaceous Series and its constituent stages (Berriasian, Valanginian, Hauterivian, Barremian, Aptian, and Albian). Nevertheless, these are traditional units of the ICS Chart and thus are units of the geologic time scale. They have content. They can be correlated into stratigraphic successions worldwide. They have long been used worldwide. Their deficiency is that limits have not been formally set for their stratigraphic content. At an ICS workshop in 2010, the proposal of Zalasiewicz et al. (2004) was considered at length and rejected unanimously by the ICS voting members, who considered the distinction as unnecessary and obvious. It is of concern that this rejected concept is being followed by the Anthropocene working group and promoted in both scientific and public media.

The focus of proponents on the beginning of the Anthropocene has led to a misrepresentation by the leaders of the working group in the lead article (Waters et al., 2014b) of *A Stratigraphical Basis for the Anthropocene* (Waters et al., 2014a). The second paragraph states, "J. Phillips used the major mass extinction at the end of the Permian in 1840 to recognize the beginning of both the Triassic Period and of the Mesozoic Era." This statement is false. The Triassic was established in 1837, and Phillips (1840) focused on the term Palaeozoic. The term Mesozoic was used only once in a list contained within parentheses. In 1841, Phillips mentioned the Mesozoic only in one sentence:

> *The lower of these …, the Magnesian Limestone formation, contains corals, brachiopoda, and fishes, so extremely similar in detail or analogous in their general history to the corresponding forms of the mountain-limestone, that it is impossible in any fair classification to sever this group of fossils from the Palæozoic series; while, on the other hand, the upper of the two formations, the Red-Sandstone and Keuper series, presents almost no resemblance to the older, but a decided analogy to the newer, or, as we wish to call it, Mesozoic series of the Oolites. (Phillips, 1841, p. 355)*

Later, in his book *Life on Earth: Its Origin and Succession*, Phillips (1860, p. 64) described the prevalent fauna in each system as rising to a maximum and dying away to a final minimum to be

followed again in the next system, with "the most remarkable of these zones of least life being the two that separate the Palaeozoic from the Mesozoic and the Mesozoic from the Cenozoic." Nowhere does Phillips (1860) mention a mass extinction as marking the beginning of the Triassic, and Phillips actually used his compilation of fossil data to argue against the theory of natural selection proposed the previous year by Charles Darwin. Yet, Waters et al. (2014b) cites Phillips (1840) to assert that human-induced changes to the stratigraphic record, although they are still yet to be recorded, are reason enough for officially recognizing the Anthropocene as a new unit on the geologic time scale. In fact, many, if not most, of the ratified GSSPs are at stratigraphic levels that do not represent major changes to the Earth system, whether geologic or biologic. For example, the bases of the Ordovician, Devonian, Carboniferous, and Permian systems are placed at the lowest occurrences of single graptolite or conodont species. They were chosen at stratigraphic levels within boundary intervals that offered the best potential for reliable, worldwide correlation. Waters et al. (2014b) also stated that units have historically been defined on significant events, when in reality it is the lack of definition of boundaries that has long plagued long-distance correlation of chronostratigraphic units. It is of concern that the history and nature of chronostratigraphic units have not been fairly conveyed.

Justification for defining the Anthropocene with a GSSA is found in the Holocene and the Precambrian. Repeated statements by Zalasiewicz et al. (2008, 2011, 2015) that the Holocene was defined by a GSSA are misleading. A formal definition of the Holocene with its base (beginning) defined by a GSSA was never approved by ICS nor ratified by IUGS; a numerical age of 10,000 ^{14}C yr B.P. was simply adopted by convention by the INQUA Holocene Commission, but it was then considered temporary (Walker et al., 2015). For the Precambrian, ICS adopted a set of numerical ages for the definition of boundaries between Archean and Proterozoic Eons and between their constituent eras (Remane et al., 1996). However, during these eons and eras, voluminous stratigraphic records accumulated and extensive bodies of plutonic and metamorphic rock were generated. Rock-based temporal classifications were established for each shield area long ago, but global units defined by isotopic ages allowed for a global standard time scale. The GSSAs were set at large round numbers, but those exact values cannot be located precisely in stratigraphic sections. Remane et al. (1996) considered them as theoretical postulates and pointed out their status only for boundary definition in the Precambrian. Today, the ICS Subcommission on Precambrian Stratigraphy is striving to replace the units defined by GSSAs with units defined by GSSPs, considering the latter to be more useful (Van Kranendonk et al., 2008). It is of concern that proponents of the Anthropocene do not fully explain the origin and concept of GSSAs.

THE NATURE AND UTILITY OF THE ANTHROPOCENE

The Anthropocene, as currently popularized, is fundamentally different from the chronostratigraphic units that are the charge of the ICS. It is the present and future versus the past. Events and effects and impact are observed, measured, and documented by humans as they occur and are dated with the Gregorian calendar (Wolff, 2014), and geologic events are too (e.g., 1906 San Francisco earthquake, 1980 eruption of Mount St. Helens). The stratigraphic record is the past. It is studied in order to *interpret* past events in Earth's history, and these interpretations require the application of stratigraphic techniques, concepts, and principles. In spite of this detachment of the Anthropocene from the concept and use of chronostratigraphic units, the term Anthropocene may have utility. It is popular among a diverse scientific community, social scientists, and the media. It does raise awareness that, as with anthropogenic climate change, the human impact on the Earth system is global, and that human impact may have initiated a cascade of events that will greatly alter Earth's surface, oceans, and atmosphere.

The term Anthropocene is of similar character to the term Renaissance. Both refer to richly documented, revolutionary, human activities that are dated in the Gregorian calendar. Both carry significant connotation. Although a precise date in calendar years is not specified for the Renaissance, the term is established and conveys a singular meaning of the content of that period, where it began, how it evolved, and how it spread. The same applies to Anthropocene if its concept is the human impact on Earth's surface. Without doubt, scholars have argued over the singular human creation, whether in literature, architecture, or art, that initiated the Renaissance, but there is no need to define its beginning, because the dates and locations of the creations are well established. Furthermore, it would be contrary to current practice to define its beginning at a single point in time because it is a cultural movement that is not tied to a single date. The same is true for the Anthropocene, whether it is a hydroelectric dam constructed in the Italian Alps, a gold mine in South Africa, the dramatic increase in carbon combustion during the Industrial Revolution, the growth of a megacity, the clearing of rain forests, or the increase in CO_2 in the atmosphere and the resulting increase in global surface temperatures. Is putting an official beginning on the Anthropocene any more advantageous than on the Renaissance? The only reason appears to be to give it credence as a unit of the geologic time scale.

The year 1945, proposed as the beginning of the Anthropocene, was selected because it marks the first atomic bomb explosion that initiated a period of atmospheric testing, the results of which are seen in radionuclides in ice cores and lake cores. The radionuclides in cores can be taken as the stratigraphic signal that most closely coincides with what has been termed the great acceleration of human impact on the Earth system (Steffen et al., 2007). That stratigraphic signal first becomes evident in deposits from 1952 to 1960, the years of extensive atmospheric testing of nuclear bombs (Waters et al., 2015). Clearly, much of the human impact used as evidence of the Anthropocene predates 1945 (e.g., Zalasiewicz et al., 2011; Waters et al., 2014b). The same would be the case with the term Renaissance, if it was arbitrarily but objectively defined by the year 1500, when the influence of the Renaissance spread from Italy to the rest of Europe. It would result in the first works of the Renaissance being relegated to the Middle Ages. In this vein, Ruddiman et al. (2015) questioned whether or not it makes sense to define the start of the human-dominated time long after deforestation and agriculture changed the landscape and after greenhouse gases had been rising due to agricultural and industrial emissions. Proponents of the Anthropocene are thus left with the question of whether or not a beginning of the Anthropocene should be set and, if so, when. They must also consider how this affects the utility of the term as used not just by stratigraphers but

also by other geologists, archaeologists, biologists, atmospheric chemists, and social scientists. Finally, it must be noted that with 1945 as the beginning, it would be a geologic time unit that presently has a duration of one average human life span.

POLITICAL STATEMENT

When we explain the fundamental difference of the Anthropocene from the chronostratigraphic units established by the International Commission on Stratigraphy to proponents for its recognition, they often reply that the human impact on the Earth system must be officially recognized, if for no other reason than to make the public and governmental agencies aware of that impact. Or, as the editorial in *Nature* (2011) argued, official recognition would encourage cross-disciplinary science and a "mindset" to understand and to take control of the current transformation. However, it is political action that is required to meet the ultimate goals of ameliorating human impact, which raises the question of the ICS making a political statement. Pope Francis has spoken out about the human-induced impact on the Earth system—so too have leaders of many nations, the United Nations, and numerous non-governmental organizations. In California, Governor Jerry Brown has initiated and promoted many legislative actions with the goal of ameliorating human-induced impact. Is the role of the ICS to make such a political statement? Would official recognition of the term Anthropocene as a unit of the ICS Chart realistically have any effect on promoting cross-disciplinary science or recognizing that we are in the driver's seat as *Nature* editorialized? Or, is that not already the case?

The evolution of vascular land plants and their spread across the continents from late in the Devonian to early in the Permian completely altered Earth's surface, left a significant stratigraphic record, and dramatically altered CO_2 and O_2 concentrations in the atmosphere and oceans far greater than humans are projected to do (Berner and Canfield, 1989; Berner, 1998). Yet there is no drive to name a unit in the ICS Chart that formally recognizes that profound and irreversible change to the Earth system. Perhaps promotion of the Anthropocene is anthropocentric as well as political?

The "Atomic Age," a term coined by *The New York Times* journalist William L. Lawrence in September 1946, has an identical boundary and content to the Anthropocene proposal of Zalasiewicz et al. (2015). By rights, the Atomic Age has nomenclatural priority. If the Anthropocene is not a political statement, those who value priority should prefer the Atomic Age.

CONCLUSIONS OR THE WAY FORWARD

No formal, written proposal has yet been submitted by the Anthropocene working group to the ICS Subcommission on Quaternary Stratigraphy. Until that happens, the ICS and the Quaternary Subcommission have nothing to consider, in spite of all that has been published by the members of the working group and by others in the scientific and public media. Assuming a formal proposal is made that recommends approval of an Anthropocene unit and boundary definition, that proposal will have to provide a detailed description of the stratigraphic content of the unit and show correlation of the lower-boundary GSSP to lake cores, ice cores, and other stratigraphic records from geographically widespread locations. It should also address questions on the concept, basis, and stratigraphic utility of the unit, such as those raised here and by Finney (2014), Head and Gibbard (2015), and Walker et al. (2015). It must consider the rank of the unit in light of the fact that its duration is that of an average human lifespan. Lastly, such a proposal should recognize that events of a proposed Anthropocene are those directly observed and precisely dated with human chronometers and calendars, and would not be interpreted from its marginal and impoverished stratigraphic record. The fundamental question that should be addressed in the proposal is this difference between the character of the Anthropocene and that of the chronostratigraphic units of the ICS chart.

Consideration of a proposal by the ICS Subcommission on Quaternary Stratigraphy and possibly then by the entire ICS will involve extensive discussion among voting members. Such discussions educate the voting members as they study the proposal, and such discussion can and should be open to those who are not voting members. Indeed, this was the nature of the discussion in 2008–2009 that preceded the ICS vote on definition of the Quaternary System and redefinition of the Pleistocene series. It is hoped that the audience of this article becomes interested and contributes to the discussion. All opinions are welcome, but all positions and arguments are subject to challenge. It is in this manner that the ICS will give careful consideration to a formal proposal when submitted.

ACKNOWLEDGMENTS

Brian Pratt and Phillip Gibbard provided reviews of the submitted manuscript. Earlier drafts were reviewed by Phillip Gibbard, Martin Head, and Mike Walker. We appreciate their thorough reviews and valuable suggestions. This article has been peer reviewed and approved for publication consistent with USGS Fundamental Science Practices (http://pubs.usgs.gov/circ/1367/).

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Manuscript received 12 Nov. 2015; accepted 22 Nov. 2015.

GSA Division Awards

ARCHAEOLOGICAL GEOLOGY DIVISION

Claude C. Albritton, Jr., Award

Nominations due 5 March
Submit nominations to gsa.agd@gmail.com

This award provides research support for graduate students in the earth sciences or archaeology. Recipients of the award are students who have (1) an interest in achieving a master's or Ph.D. degree in earth sciences or archaeology; (2) an interest in applying earth-science methods to archaeological research; and (3) an interest in a career in teaching and academic research. Learn more at www.geosociety.org/arch/.

Richard Hay Student Paper/Poster Award

Nominations due 20 August
Submit nominations to gsa.agd@gmail.com

This award is a travel grant for a student (undergraduate or graduate) who is presenting a paper or poster at GSA's annual meeting. It is given based on evaluation of the scientific merit of the research topic and the clarity of an expanded abstract for a student presentation in the Division's technical session at the meeting. Learn more at www.geosociety.org/arch/.

ENERGY GEOLOGY DIVISION

Antoinette Lierman Medlin Scholarship in Coal Geology

Applications due 15 March
Submit nominations to J. Fred McLaughlin, derf1@uwyo.edu

This award provides monetary support and recognition to deserving graduate students in coal science. The scholarships are used toward successful completion of student research projects. Each year, one award is presented for the completion of laboratory/analytical research (US$2,500) and a second award is presented for the completion of fieldwork (US$1,500). Learn more at www.uky.edu/KGS/coal/GSA/awards.htm.

HISTORY AND PHILOSOPHY OF GEOLOGY DIVISION

History and Philosophy of Geology Student Award

Nominations due 15 June
Submit nominations to Kathleen Lohff, Secretary/Treasurer, kathylohff@msn.com

This student award, in the amount of US$1000, is provided for a paper to be given at the GSA Annual Meeting. The proposed paper may be (1) a paper in the history or philosophy of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history or philosophy of geology we have not thought of before. Learn more at community.geosociety.org/histphildiv/awards#dsa.

MINERALOGY, GEOCHEMISTRY, PETROLOGY, AND VOLCANOLOGY (MGPV) DIVISION

MGPV Distinguished Geologic Career Award

Nominations due 15 July
Submit nominations to J. Alex Speer, jaspeer@minsocam.org

This award will go to an individual who, throughout his or her career, has made distinguished contributions in one or more of the following fields of research: mineralogy, geochemistry, petrology, volcanology, with emphasis on multidisciplinary, field-based contributions. Learn more at www.geosociety.org/divisions/mgpv/awards.htm.

MGPV Early Career Award

Nominations due 15 July
Submit nominations to J. Alex Speer, jaspeer@minsocam.org

This award will go to an individual near the beginning of his/her professional career who has made distinguished contributions in one or more of the following fields of research: mineralogy, geochemistry, petrology, volcanology, with emphasis on multidisciplinary, field-based contributions. Nominations are restricted to those who are within eight years past the award of their final degree. Learn more at www.geosociety.org/divisions/mgpv/awards.htm.

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

Farouk El-Baz Award for Desert Research

Nominations due 1 April
Submit nominations to Anne Chin, anne.chin@ucdenver.edu

This award recognizes excellence in desert geomorphology research worldwide. It is intended to stimulate research in desert environments by recognizing an individual whose research has significantly advanced the understanding of the Quaternary geology and geomorphology of deserts. Learn more at http://rock.geosociety.org/qgg/.

Distinguished Career Award

Nominations due 1 April
Submit nominations to Sarah Lewis, Division Secretary, sarah.lewis@oregonstate.edu

This award is presented annually to a Quaternary geologist or geomorphologist who has demonstrated excellence in their contributions to science. Learn more at http://rock.geosociety.org/qgg/.

SEDIMENTARY GEOLOGY DIVISION AND STRUCTURAL GEOLOGY AND TECTONIC DIVISION JOINT AWARD

Stephen E. Laubach Structural Diagenesis Research Award

Nominations due 1 April
Submit nominations to James Evans at james.evans@usu.edu

This joint award promotes research combining structural geology and diagenesis and curriculum development in structural diagenesis. It highlights the growing need to break down disciplinary boundaries between structural geology and sedimentary petrology. Note that the application includes a budget page; we anticipate giving one award of US$2500 in 2016. For more information, go to http://rock.geosociety.org/sgt/Laubach.htm.

CALL FOR NOMINATIONS

John C. Frye Environmental Geology Award

Nominations due 31 March

What's the best paper on environmental geology you've read lately?

This US$1,000 cash award recognizes the best paper on environmental geology published by GSA or by a state geological survey within the past three years. To nominate a report, please submit a letter describing its importance, with up to three letters from users of the publication, along with three copies of the publication, to Recognition Manager, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, awards@geosociety.org. Learn more at **www.geosociety.org/awards/fryhow.htm.**

Take note: *The meeting is early this year.*

25–28 SEPTEMBER

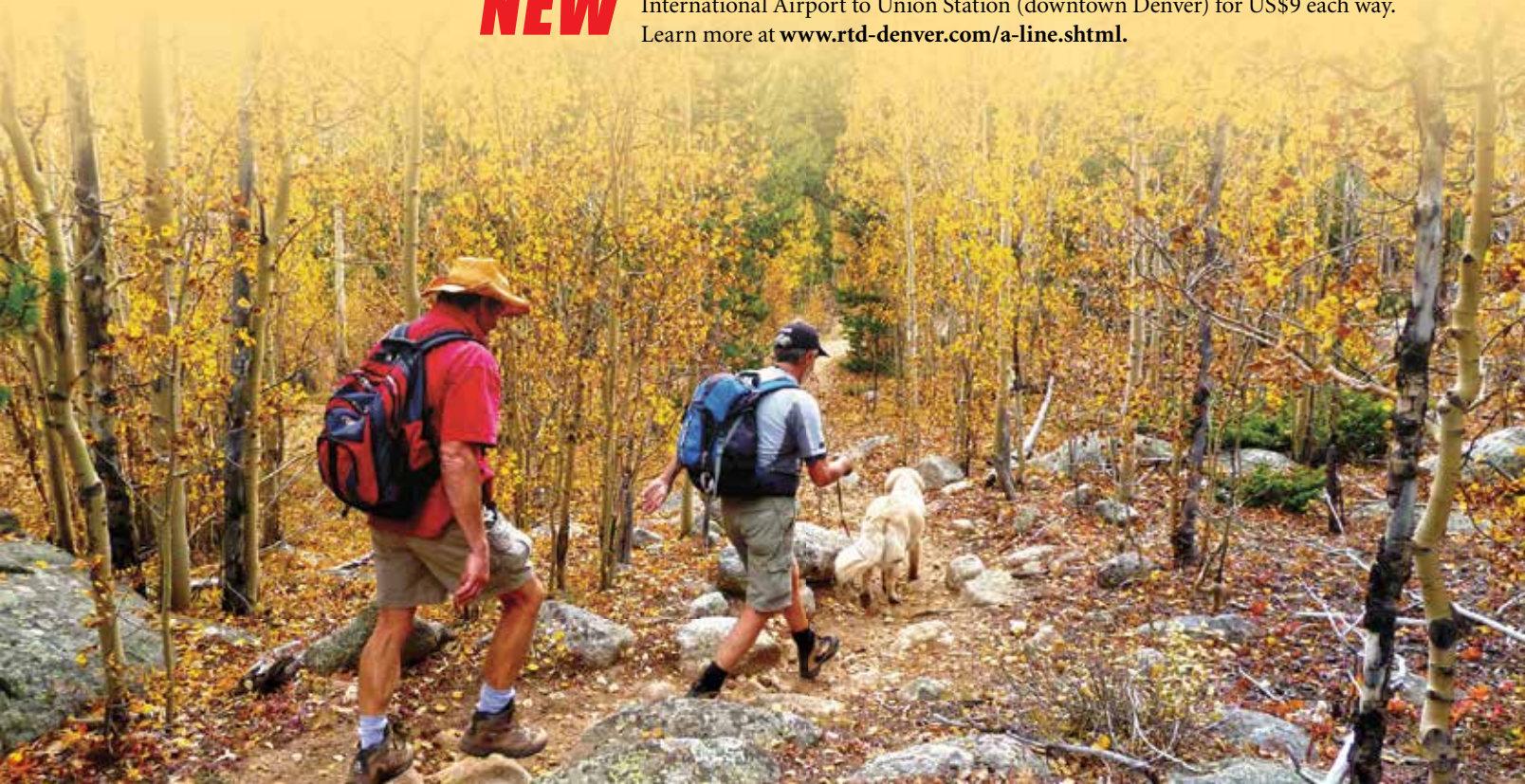
GSA 2016

Denver, Colorado, USA

IMPORTANT DATES

Late March	Meeting room request system opens (non-technical, social, and business meeting room requests)
Early May	Registration, housing, and student volunteer program applications open
5 May	Meeting room request system deadline—Fees increase after this date for all submissions
12 July	**Abstracts deadline**
22 August	Early registration deadline
22 August	GSA Sections travel grants deadline
29 August	Registration cancellation deadline
31 August	Housing deadline for discounted hotel rates

NEW **Starting 22 April,** travelers will be able to take the commuter rail from Denver International Airport to Union Station (downtown Denver) for US$9 each way. Learn more at **www.rtd-denver.com/a-line.shtml.**



HOTEL INFORMATION

The official GSA Housing Bureau will open in early May. The headquarter hotel is the Hyatt Regency CCC, and we have nine other hotels in our block with rates ranging from $161 to $223 per night, plus tax. All hotels are within walking distance of the Colorado Convention Center.

Don't be misled: The GSA Housing Bureau will NOT call, fax, or email you to inquire if you want to make a hotel reservation for the conference. Beware of anyone contacting you directly to make a hotel reservation. Only provide your personal information to an organization you trust and that you have contacted directly. If you have any questions, please contact the GSA Meetings Department at meetings@geosociety.org or +1-303-357-1041. We will post information to our website regarding hotel reservations in the GSA room block in early May.

The Geological Society of America® ON TO THE FUTURE

Be the Leader You Were Meant to Be

Apply for On To the Future (OTF) travel awards and receive funding and mentorship at your first GSA Annual Meeting—this year in Denver, Colorado, USA, on 25–28 September 2016.

Diverse and underrepresented students and recent graduates are encouraged to apply. As an awardee, you will gain exposure to an array of geoscience research, career options, and networking opportunities, and interact with GSA leadership at the meeting.

Check the OTF website, **community.geosociety.org/OTF/home/myhome,** for eligibility guidelines and application information. *Questions?* Contact Tahlia Bear, tbear@geosociety.org.

Deadline to apply: 27 May.

THE GEOLOGICAL SOCIETY OF AMERICA®

Photos courtesy of the Denver Metro Convention & Visitors Bureau.

Get into The Field with These GSA & ExxonMobil Awards

The importance of field schools to practicing geologists is unquestionable, yet the opportunities to experience field geology are dwindling. The **Geological Society of America** (GSA), in cooperation with **ExxonMobil**, offers **two programs** to support and encourage field geology. This collaboration has proven very successful; in 2015, several hundred geology students and professors applied for these awards.

THE GSA/EXXONMOBIL FIELD CAMP SCHOLAR AWARD

Who should apply? Undergraduate students

Deadline to apply: 16 April

This year's field award will provide US$2,000 each to 20 undergraduate students so they can attend the summer field camp of their choice. These scholarships are based on diversity, economic/financial need, and merit. Funds for this award have been provided by ExxonMobil. Selections of awardees are completed by GSA.

"The Field Camp Scholar Award is a wonderful opportunity enabling hard-working and passionate geology majors to gain hands-on experience in applying geological principles in the field."

GSA/EXXONMOBIL FIELD CAMP EXCELLENCE AWARD

Who should apply? Anyone, but the award must be used toward field camp operations

Deadline to apply: 16 April

One field camp instructor/director will receive an award of US$10,000 to assist with his or her summer field season. This award will be based on safety awareness, diversity, and technical excellence.

"Thank you for this honor. Our students and faculty will be thrilled!"

To apply for these awards, go to **https://rock.geosociety.org/eo/.** Students and recent graduates must submit an online application form, two letters of recommendation, and a cover letter.

Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org, or +1-303-357-1036.

Participant Casey John in Grand Teton National Park.

National Park Service Geoscientists-In-the-Parks (GIP) Opportunities

FALL/WINTER 2016–2017

The NPS GIP program places college students and early career professionals (18–35 years old) in National Park Service units for three months to one year to assist with geology and integrated science projects. This program is a partnership between the National Park Service, the Geological Society of America, and Environmental Stewards. Opportunities for fall/winter will be posted by GSA and open for application starting 1 May. The application deadline is 1 July.

http://rock.geosociety.org/g_corps/index_gip.htm

THE GEOLOGICAL SOCIETY OF AMERICA®

GeoCorps™ America

FALL/WINTER 2016–2017

The next GeoCorps America fall/winter season runs from September 2016 through May 2017. All fall/winter GeoCorps positions will be posted on the GeoCorps website and be open for applications starting 1 May. The application deadline is 1 July.

GeoCorps provides paid geoscience opportunities in partnership with government agencies and other organizations committed to science and stewardship, including the U.S. Forest Service and the Bureau of Land Management (BLM). All levels of geoscientists—students, educators, professionals, retirees, and others—are encouraged to apply.

www.geosociety.org/geocorps

www.facebook.com/GeoCorps

THE GEOLOGICAL SOCIETY OF AMERICA®

2016 GSA
Section Meetings

SOUTH-CENTRAL
21–22 March
Hilton Baton Rouge Capitol Center,
Baton Rouge, Louisiana, USA

NORTHEASTERN
21–23 March
Empire State Plaza Convention Center,
Albany, New York, USA

SOUTHEASTERN
31 March–1 April
Columbia Metropolitan Convention Center,
Columbia, South Carolina, USA

CORDILLERAN
4–6 April
Ontario Convention Center,
Ontario, California, USA

NORTH-CENTRAL
18–19 April
I-Hotel and Conference Center,
Champaign, Illinois, USA

ROCKY MOUNTAIN
18–19 May
University of Idaho,
Moscow, Idaho, USA

THE GEOLOGICAL SOCIETY OF AMERICA®

www.geosociety.org/sections

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GSA Education & Outreach Programs: 2016 Section Meetings

ON TO THE FUTURE (OTF)

Stop by the GSA Foundation booth at your Section Meeting's Welcome Reception to find out about applying to OTF, which provides travel support to students underrepresented in the geosciences to attend their first GSA Annual Meeting (the next one is 25–28 Sept. 2016 in Denver, Colorado, USA).

CAREER WORKSHOPS

Geoscience Career Workshop Part 1: Career Planning and Informational Interviewing: Job-hunting begins with career planning, and this workshop will help you get started with an introduction to informational interviewing.

Geoscience Career Workshop Part 2: Geoscience Career Exploration: How much do geologists make? What are the pros and cons of working in academia, government, and industry? Get those answers and more in this career exploration workshop.

Geoscience Career Workshop Part 3 (day 2): Cover Letters, Résumés, and CVs: How do you prepare a cover letter? Does your résumé need a good edit? Use this opportunity to learn the dos and don'ts of putting together the kind of résumés and cover letters employers want to see.

MENTOR PROGRAMS

The Roy J. Shlemon Mentor Program in Applied Geoscience and the John Mann Mentors in Applied Hydrogeology Program offer students the opportunity to meet with geoscience mentors who work in the applied sector. These luncheon events are so popular that space is limited—plan to arrive early because lunch is first-come, first-served. Questions? Contact Jennifer Nocerino at jnocerino@geosociety.org.

South-Central Section

Baton Rouge, Louisiana, USA
Shlemon Applied Geoscience Luncheon: Mon., 21 March
Mann Applied Hydrogeology Luncheon: Tues., 22 March

Northeastern Section

Albany, New York, USA
Shlemon Applied Geoscience Luncheon: Mon., 21 March
Mann Applied Hydrogeology Luncheon: Tues., 22 March

Southeastern Section

Columbia, South Carolina, USA
Shlemon Applied Geoscience Luncheon: Thurs., 31 March
Mann Applied Hydrogeology Luncheon: Fri., 1 April

Cordilleran Section

Ontario, California, USA
Shlemon Applied Geoscience Luncheon: Mon., 4 April
Mann Applied Hydrogeology Luncheon: Tues., 5 April

North-Central Section

Champaign, Illinois, USA
Shlemon Applied Geoscience Luncheon: Mon., 18 April
Mann Applied Hydrogeology Luncheon: Tues., 19 April

Rocky Mountain Section

Moscow, Idaho, USA
Shlemon Applied Geoscience Luncheon: Wed., 18 May
Mann Hydrogeology Luncheon: Thurs., 19 May

The **Numbers** Are **Up** for *GSA Today*

Analyzing the numbers for 25 years of *GSA Today* science articles (1991–2015) leads to some interesting statistics, including top page views and top citations. Some science articles have become hot topics, as seen either by number of citations or number of page views.

Page Views

GSA Today reaches a wide and diverse audience. All articles are open-access online. The highest year for page views was 2012, with 54,512 views so far (html files only, does not count abstract or PDF views; see Fig. 1 and Table 1). The paper with the greatest number of page views is "An anthropogenic marker horizon in the future rock record," by Patricia L. Corcoran et al., from June 2014 (v. 24, no. 6, p. 4–8) (see Fig. 2).

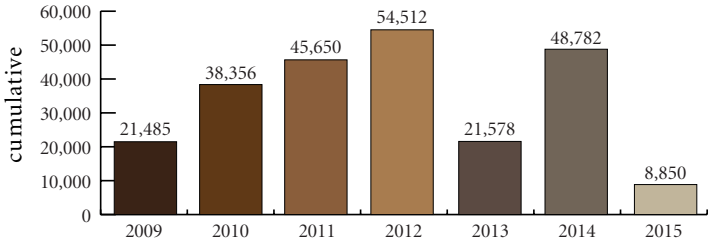

Figure 1. *GSA Today* science article page views per year (cumulative). Total: 239,213. (Google Analytics data for full-article html files only; data were not recorded prior to 2009.) The number of manuscripts per year varies; see Table 2.

Figure 2. June 2014 *GSA Today* cover featuring the top-most viewed *GSA Today* science article of all time (30,598 views), due in part to the wide media coverage it received, including articles in LiveScience, *Science*, Scientific American (podcast), *The New York Times*, The Weather Channel, *Hawaii Tribune Herald*, Fox News (video and interview with one of the authors), CBS News, the Huffington Post, *Forbes*, and *American Scientist*. Links to media coverage of GSA science are online at www.geosociety.org/news/scienceNews.htm.

Citations

Since its premier in 1991, *GSA Today* has generated a large proportion of citations considering that only one peer-reviewed science article is published per issue. The top year for citations was 1997, with 1,660 (see Fig. 3). The paper with the greatest number of citations is from April 1997: "Global Seismic Tomography: A Snapshot of Convection in the Earth," by Stephen P. Grand et al. (v. 7, no. 3, p. 4–7) (see Fig. 4). For science article totals per year, see Table 2.

Other highly cited articles include 2008's "A geological and geophysical context for the Wenchuan earthquake of 12 May 2008, Sichuan, People's Republic of China," by B. Clark Burchfiel et al. (v. 18, no. 7, p. 4–11), with 538 citations. This article is also unique because it appeared in print less than two months after the event (see Fig. 5).

The second most-viewed article is "The evolution of creationism," by David R. Montgomery (v. 22, no. 11, p. 4–9), with 18,398 page views so far (per Google Analytics data for 2009–2015 only).

For a full list of *GSA Today* science article statistics (to be updated quarterly), go to www.geosociety.org/gsatoday/ and click on the "View Statistics" button.

Table 1. Most Viewed Science Articles 2009–2015

Month /year	Article	Page views*	Avg. time on page	Cites
Aug. 2015	"Pleistocene relative sea levels in the Chesapeake Bay region and their implications for the next century"	3,369	2 min, 54 sec	0
June 2014	"An anthropogenic marker horizon in the future rock record"	30,598	4 min, 24 sec	25
Feb. 2013	"Miocene rejuvenation of topographic relief in the southern Appalachians"	3,650	4 min, 24 sec	49
Nov. 2012	"The evolution of creationism"	18,398	6 min, 36 sec	3
Jan. 2011	"Microbial communities in fluid inclusions and long-term survival in halite"	16,435	2 min, 4 sec	66
Apr./ May 2010	"The digital revolution in geologic mapping"	10,206	3 min, 23 sec	51
Sept. 2009	"The Portland Basin: A (big) river runs through it"	5,635	4 min, 25 sec	12

Note: Google Analytics and Google Scholar Data obtained 4 Feb. 2016.
*HTML page views only; no PDF data available.

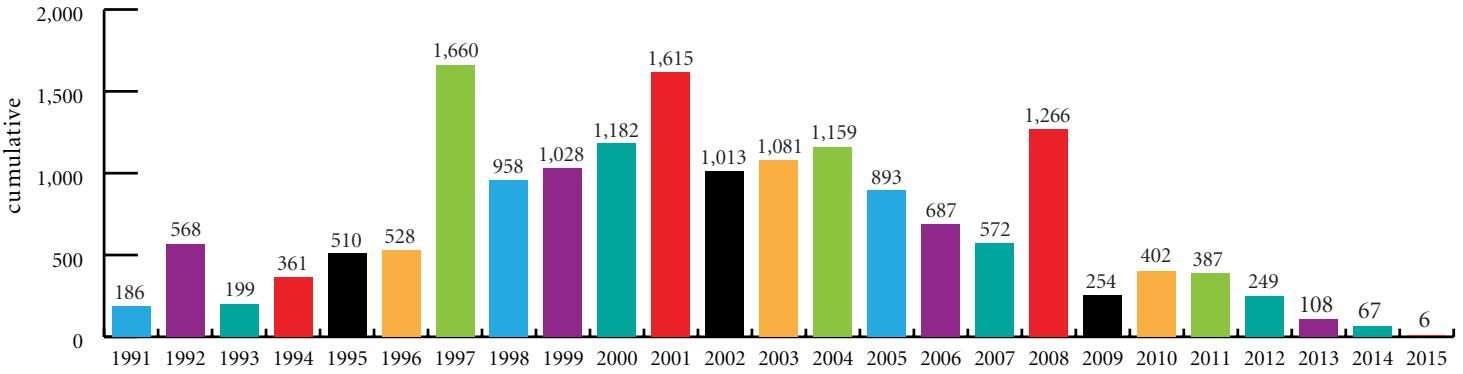

Figure 3. *GSA Today* science article citations per year. Total: 16,937. Google Scholar data, Jan. 2016.

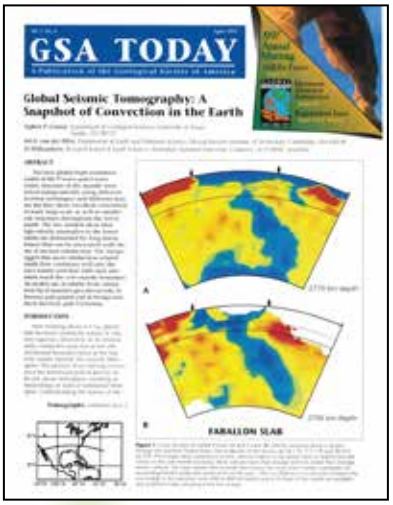

Figure 4. April 1997 cover featuring the top-most cited *GSA Today* science article of all time (828 citations).

Table 2. Number of science articles per year

2015	9
2014	10
2013	8
2012	11
2011	14
2010	11
2009	10
2008	10
2007	10
2006	9
2005	10
2004	8
2003	9
2002	10
2001	12
2000	12
1999	11
1998	13
1997	11
1996	11
1995	11
1994	11
1993	11
1992	9
1991	11

Note: Total: 262; average: 10.48.

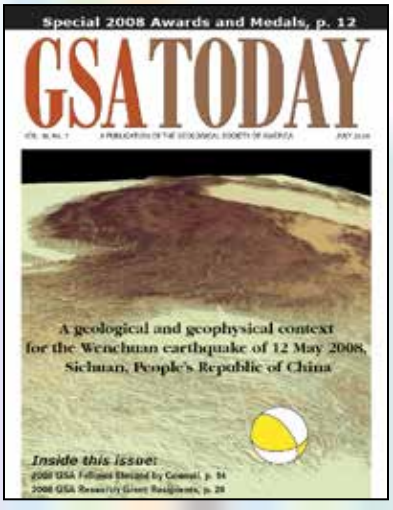

Figure 5. July 2008 cover featuring the fastest to-press science article.

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EarthCaching gets people out in the field to learn about their planet first-hand. Participants in this annual event will learn all about EarthCaching, interact with EarthCachers from around the globe, meet EarthCache developers and reviewers, find local EarthCaches, and engage in many other exciting and educational activities. The 2016 event will be held in conjunction with the GSA Annual Meeting, which provides a unique opportunity for GSA members to connect with the EarthCaching and Geocaching communities! For details, go to www.earthcache.org, www.facebook.com/earthcache, or contact Matt Dawson at mdawson@geosociety.org.

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— 2015 Rendezvous Participant

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The meeting will bring together activities that support all levels of educators in:

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- **building a collective capacity to use and conduct education research**
- **increasing overall impact on Earth education**

View the program, register, and get updates:
http://serc.carleton.edu/earth_rendezvous/2016/

Early Bird Registration by May 2, 2016

Why GSA Membership Is Important to Me

Mariah "Maisie" Richards in Denali National Park, USA.

When I was little, the tooth fairy would bring me pretty rocks instead of the more common silver dollars. I never knew there was a whole community of people that similarly valued the shine of quartz over a crisp dollar bill until I attended my first GSA meeting.

I graduated from Colorado College in 2011 and immediately headed up to Denali National Park and Preserve to look for dinosaur footprints through GSA's GeoCorps America Program. That research led me to my first GSA Annual Meeting the following fall, where I spent most of my time, truth be told, perusing the extensive exhibit booths dedicated to glittery rocks and fossil jewelry.

Up until that point, I had been intimidated by phrases such as "networking" and "LinkedIn," until I recognized that I am an inherently chatty person and "networking" is really just casual chatting with fellow professionals. Realizing this, I approached a speaker who stuck out to me in a panel session on geology in government. Because of this conversation, she later became my supervisor at Death Valley National Park as well as a lifelong mentor.

I continued my GSA membership throughout the following years as I dabbled in forest ecology and returned seasonally to Denali as a park employee. My introduction to Denali through GeoCorps led to research that resulted in a masters project proposal that received the Arthur D. Howard Award this fall and is funded in large part by Denali.

You can only make sense of and see patterns in the choices you've made in self reflection, but now I can see a very clear trend. GSA, in the forms of inspiring programs, grants and awards, and beautiful rocks, has been there to help guide me along my winding path that began when I found a shiny quartz crystal beneath my pillow.

Mariah "Maisie" Richards
Graduate Student at Colorado State University
GSA Member since 2010

CALL FOR COMMITTEE SERVICE

✔ Your Science
✔ Your Colleagues
✔ Your Society

Impact the Future of Geoscience

2017–2018 VACANCIES

Deadline to apply or submit nominations: 15 June

If you are looking for the opportunity to work toward a common goal, a place to network with other geoscientists, or a way to make a difference for GSA and the larger geoscience community—then we invite you to volunteer (or nominate a fellow GSA Member) to serve on a GSA Committee or as a GSA representative to another organization. Learn more at **www.geosociety.org/aboutus/committees/.** You can also watch our governance overview YouTube video at **https://youtu.be/1k3V4gVOV7k.**

COMMITTEE	Number of Vacancies	Length of Term
Annual Program Committee (B, E, M)	two	3 years, 2 years
Arthur L. Day Medal Award (E, T)	two	3 years
Diversity in the Geosciences (E, M)	two	3 years
Education (B, E M)	four	4 years
Geologic Mapping Award (E)	one	3 years
Geology and Public Policy (B, E, M)	two	3 years
GSA International (M, E)	three	4 years
Joint Technical Program (E)	one	2 years
Membership (B) Academia-Related	three	3 years
Nominations (B, E)	three	3 years, 2 years
Penrose Conferences and Field Forums (E)	one	3 years
Penrose Medal Award (E)	two	3 years
Professional Development (E)	two	3 years
GSA Public Service Award (E)	two	3 years
Publications (B, E, M)	one	4 years
Research Grants (B, T)	eight	3 years
Research Grants Alternates (B, T) (if needed)	five	3 years
Student Advisory Council (E, M) (must be a GSA Section or Division member)		2 years
Young Scientist Award (Donath Medal) (E)	two	3 years
OTHER ORGANIZATION	Number of Vacancies	Length of Term
GSA Conferee to the AAPG Publication Pipeline Committee (M, possibly B)	one	3 years

B—Meets in Boulder or elsewhere
E—Communicates by phone or electronically
M—Meets at the Annual Meeting
T—Extensive time commitment required during application review period (15 Feb.–15 Apr. 2017)

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NOW AT GSA: Your Time to Shine

Volunteer or nominate a colleague to serve as a GSA Officer, Councilor, or committee member. Deadline: **15 June** (terms begin July 2017). Student members are especially encouraged to bring their unique points of view to GSA leadership.

Links to Learn More

Officers & Councilors: www.geosociety.org/aboutus/officers.htm

Committees: www.geosociety.org/aboutus/committees

THE GEOLOGICAL SOCIETY OF AMERICA®

ELECTIONS: GSA OFFICERS and COUNCILORS

GSA ELECTIONS BEGIN 11 MARCH 2016

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council. Members will receive instructions for accessing a member-only electronic ballot via our secure website, and biographical information on the nominees will be online for review at that time. Paper versions of both the ballot and candidate information will also be available upon request. Contact Susan Lofton, slofton@geosociety.org, for more information. Ballots must be submitted electronically, faxed to GSA Headquarters, or postmarked by **10 April 2016.**

2016 OFFICER NOMINEES

PRESIDENT	VICE PRESIDENT/PRESIDENT-ELECT	TREASURER
(July 2016–June 2017)	(July 2016–June 2017)	(continuing term, July 2016–June 2017)
Claudia I. Mora	**Isabel Montanez**	**Bruce R. Clark**
Los Alamos National Laboratory	University of California Davis	The Leighton Group Inc.
Los Alamos, New Mexico, USA	Davis, California, USA	Irvine, California, USA
We congratulate our incoming president!		

2016 COUNCIL NOMINEES

COUNCILOR POSITION 1	COUNCILOR POSITION 2	COUNCILOR POSITION 3
(July 2016–June 2020)	(July 2016–June 2020)	(July 2016–June 2020)
Ed Harvey	**Mark Little**	**Donna L. Whitney**
National Park Service	University of North Carolina	University of Minnesota
Denver, Colorado, USA	Chapel Hill, North Carolina, USA	Minneapolis, Minnesota, USA
Christopher L. Andronicos	**Dave Szymanski**	**Marjorie A. Chan**
Purdue University	Bentley University	University of Utah
West Lafayette, Indiana, USA	Waltham, Massachusetts, USA	Salt Lake City, Utah, USA

Ballots must be submitted electronically or postmarked by 10 April 2016.

Geoscience Jobs & Opportunities

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact advertising@geosociety.org, +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses.
Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Positions Open	$9.20	$8.95
Fellowship Opportunities	$9.20	$8.95
Opportunities for Students		
First 25 lines	$0.00	$5.00
Additional lines	$5.00	$5.00

Positions Open

DIRECTOR, SUBSURFACE ENERGY RESOURCE CENTER
SCHOOL OF EARTH SCIENCES
OHIO STATE UNIVERSITY

Description: The Ohio State University invites applications for the position of Director of the Subsurface Energy Resource Center (SERC) at the rank of full professor with tenure. We seek a visionary leader for SERC who will foster its mission to facilitate research, education, and outreach involving academia, industry, and numerous stakeholders to understand and enable efficient, economic, and socially responsible use of energy resources with a reduced environmental footprint. SERC was established at The Ohio State University in 2011 in response to recent technical advances that are leading to the rapid expansion of horizontal drilling operations for hydrocarbon-bearing shale in eastern Ohio. As one of the nation's largest research universities and the state's land-grant institution, Ohio State has a wealth of expertise to contribute to subsurface resource development and its associated environmental issues, as well as a responsibility to serve as a resource for policy makers. Shale development has been the near-term primary focus of SERC, but the scope of SERC and the Director's responsibilities encompass the full spectrum of subsurface energy resources. This position is partially funded by Ohio State's Discovery Themes, a significant investment in key thematic areas in which the university can build on its culture of academic collaboration to make a global impact.

Qualifications: We seek a national and/or international expert who holds a Ph.D. in fields related to subsurface energy science, related environmental science and/or technology; or other relevant fields and has a proven track record of productivity and excellence in research and teaching. He/she will understand the importance to SERC of a fair and balanced research portfolio in energy and related environmental, economic, and social issues, and outreach; will understand and embrace the importance of extension and outreach; and will have experience working with groups from varied technical backgrounds ranging from layperson to expert. Previous experience in organizing and administering large research programs or a center is desired. The candidate is expected to build strong collaborations with faculty from varied departments across the university and orchestrate large multi-disciplinary/multi-institutional proposals. Candidates experienced in university structure and functions, expectations of faculty, and the importance of curriculum development are desired. Individuals with extensive contacts and experience with federal funding agencies such as DoE, DoD/ARPA-E, and NSF, nonfederal foundations, major energy companies, and manufacturers are encouraged to apply.

About Columbus: The Ohio State University campus is located in Columbus, the capital city of Ohio. Columbus is the center of a rapidly growing and diverse metropolitan area with a population of over 1.5 million. The area offers a wide range of affordable housing, many cultural and recreational opportunities, excellent schools, and a strong economy based on government as well as service, transportation and technology industries (see http://liveworkplaycolumbus.com). Columbus has consistently been rated as one of the Top U.S. cities for quality of life. Additional information about the Columbus area is available at http://www.columbus.org.

Application Instructions: Apply to Academic Jobs Online at http://academicjobsonline.org/ajo/jobs/6952. Complete applications include: (1) curriculum vitae, (2) statement of research interests and teaching goals, (3) a vision statement describing the nexus of subsurface science, its development, and potential societal and environmental impacts, (4) names, addresses and emails of at least four professional references. Review of applications begins immediately and continues until the positions are filled. Candidates may contact the search committee chair, Prof. David Cole at cole.618@osu.edu .

The Ohio State University is committed to establishing a culturally and intellectually diverse environment, encouraging all members of our learning community to reach their full potential. We are responsive to dual-career families and strongly promote work-life balance to support our community members through a suite of institutionalized policies. We are an NSF Advance Institution and a member of the Ohio/Western Pennsylvania/West Virginia Higher Education Recruitment Consortium (HERC).

The Ohio State University is an equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability status, or protected veteran status.

ENDOWED OPEN RANK POSITION
IN QUANTITATIVE GEOSCIENCES
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The Department of Geological Sciences at Michigan State University [MSU] invites outstanding candidates to apply for a full-time academic year endowed open rank tenure system position in geosciences starting in Fall 2016. We encourage applications from across a broad spectrum of geoscience research areas from individuals who employ advanced quantitative and computational analysis in their research. We are seeking candidates who will develop a vigorous externally-funded research program, teach and advise undergraduate and graduate students, contribute to a collegial and inclusive environment, and engage in collaborative endeavors.

MSU is committed to achieving excellence through diversity and encourages applications from women, persons of color, veterans, and persons with disabilities, and we endeavor to facilitate employment assistance to spouses or partners of candidates for faculty positions.

Details on how to apply will be found at jobs.msu.edu under posting number 2591. We will begin reviewing applications in March 2016 but the position will remain open until filled. Questions regarding this position can be directed to M.D. Gottfried, Chair of the Search Committee, at gottfrie@msu.edu.

Check out the Job Board for latest recruitment postings.

John W. (Jack) Hess, *GSA Foundation President*

The Value of Corporate Partnerships: Anadarko Petroleum Corporation

Students visiting with Anadarko during the 2015 GeoCareers in Industry program at GSA's Annual Meeting.

GSA programs benefit greatly from corporate partners that support a range of opportunities, such as career programs, diversity initiatives, field camps, teacher excellence recognition, students' field camp attendance, undergraduate diversity scholarships, and more.

For the last four years, Anadarko Petroleum Corporation has been one of several companies teaching the "Sequence Stratigraphy for Graduate Students" short course at GSA's Annual Meeting. We were thrilled to have the company come on board as an inaugural sponsor of GeoCareers in Industry, paving the way in 2013 as lead sponsor of the new program during GSA's 125th anniversary year. Consistent with its commitment to corporate responsibility, Anadarko supports efforts to enhance educational opportunities for students interested in careers in industry, recognizing that continued involvement is vital for long-term benefits through changing industry conditions.

Anadarko's involvement with the GeoCareers program has resulted in the hiring of at least one GSA student, Kathryn Dianiska, who works as a geologist in onshore exploration at Anadarko.

The company's association with GSA contributes in additional ways to our Society: Their former geoscience career development and recruiting manager, retired, now serves as an active member of the GSAF Board of Trustees, bringing strong insight to our efforts in corporate partnerships and beyond. Anadarko also plans to participate with an additional short course, hosted at their Rockies regional headquarters, during the GSA 2016 Annual Meeting in Denver.

We thank Anadarko and all of the companies that have joined us in expanding the meaningful benefits of partnership. If your company would like to participate in fostering the growth of current and future leaders in the geoscience community, engaging industry as a positive force to advance science, stewardship, and service, please contact Debbie Marcinkowski at +1-303-357-1047 or dmarcinkowski@geosociety.org.

Our participation with GSA enables us to meet students beyond our normal reach and share knowledge about the fundamental importance of the oil and natural gas industry to modern life. We appreciate the quality of GSA's meeting and its student attendees, and as a result, we expect to continue this valuable partnership. — Gary White, Exploration Manager, Geoscience Career Development & Recruiting, Anadarko

Kathryn Dianiska doing fieldwork on folded granulites in Fjordland, New Zealand.

GROUNDWORK
Furthering the Influence of Earth Science

Building a coalition of concerned stakeholders to guide watershed decisions

J.M.H. Cockburn, *Dept. of Geography, University of Guelph, Guelph, Ontario, Canada; and* ***J.I. Garver,*** *Dept. of Geology, Union College, Schenectady, New York, USA*

Dam removal, spills, and epic flooding are important events that can energize and galvanize people in a watershed. But in ordinary circumstances, what is the catalyst that brings these individuals together and unifies them in efforts to improve water quality, reduce the impact of flooding, and addresses other issues? Building and sustaining a coalition of concerned and invested stakeholders allow us to be more connected and informed about important issues that affect water quality, recreation opportunities, and other demands on water use. Surface water is used for many purposes that often compete with one another in the regulatory and policy arena. We suggest that the geoscience community is well positioned to play a lead role in bridging the gap between science and policy and in guiding public discourse in watershed issues.

Consider a hypothetical competition over a river in the northeastern United States: On one hand is the requirement for minimum discharge levels and water temperatures to sustain a native trout fishery, and on the other hand there is the direct economic benefit of water-taking to satisfy high water demand industries, such as microchip manufacturing plants. A situation like this may be polarizing, but resolution and equity are likely to be achieved if all sides have a voice in the decision-making process. Without a regional awareness of competing needs and interests, poor decision-making can result in asymmetric rules for taking, using, and managing finite water resources.

Thus, a key to guiding watershed management is to establish a working dialog among stakeholders. There are many examples and attempts at building discourse among various stakeholders within a watershed, and we believe geoscientists can play a pivotal role in facilitating this discourse. Here we highlight the success we have had with the Mohawk Watershed Symposium (MWS) in New York State as an example of how an annual conference focused on watershed issues can level the playing field and provide a forum for competing and complementary interests.

The Mohawk Watershed in east-central New York State is typical of many watersheds in the eastern United States, where a number of different, but not mutually exclusive, interests pull policy and science in more than one direction. Issues surrounding clean water and a healthy ecosystem dovetail with recreation and economic opportunities along the primary river corridor. These interests are complicated by changes in the overall hydrology, including flood and drought regimes (e.g., Cockburn and Garver, 2015), point-source pollution, and water extraction for use by industry and municipalities.

We have discovered that basin stakeholders are many and diverse, but all derive value in the basic resources a watershed has to offer. However, the concerns of a fly fisherman may have little in common with a microchip manufacturer, except they all rely on the availability of abundant clean water. Likewise, several tiers of municipal, state, and federal government agencies represent the rule-makers and enforcers. In our experience, the small stakeholders, who may be more familiar with local issues, tend to lack the organizational and political clout to affect policy directions in a meaningful and sustainable way. We believe our success is grounded in the guiding principle that informed decisions come out of evidence-based science and open discussions.

In the Mohawk Watershed, relationships have been strained in the wake of several recent floods and water-use issues related to dams. In light of these problems, we recognized the need to bring stakeholders together, and in 2009, we established the MWS. This annual symposium builds momentum and significance by bringing stakeholders together and establishing a dialog between groups working and living in the basin.

The MWS has important and far-reaching successes, in part because our efforts cast the light on an underappreciated asset in New York State. Many of the major successes in the basin grew from dialog and partnerships, and the MWS has been instrumental in facilitating this exchange. Paramount among them is initiating a dialog between stakeholders and allowing for a meaningful exchange of ideas.

This dialog facilitated the New York State Department of Environmental Conservation (NYSDEC) Mohawk Watershed Agenda and the newly released Mohawk Watershed Management plan. In the past two years, appropriations from the state have resulted in Mohawk River Basin Action Agenda Grants that provide funding for projects that enhance: (1) habitats, ecosystems, and water quality; (2) flood hazard risk reduction; (3) community planning and revitalization; and (4) working landscapes, land use, and open space. MWS discussions and priorities fed into the Hudson-Mohawk River Basin Act, which was introduced in the U.S. Congress in 2013 by Congressman Tonko (it was not enacted).

The meeting is hosted in a neutral academic environment, which has served as a pivot point between state and federal government organizations (such as the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and

GSA Today, v. 26, no. 3–4, 10.1130/GSAT267GW.1.

NYSDEC), schools and universities, and non-governmental organization interests, primarily those of citizen advocacy groups and municipal entities. Although the meeting explores policy, history, and education, topics center on watershed science such that the community understands hydrology and water quality, and the depth of that science is one key aspect of stakeholder buy-in.

Stakeholder-driven watershed meetings are not a new idea (e.g., Leach et al., 2002; Smutko et al., 2002), but we believe the long-lasting interest and investment achieved through the MWS is noteworthy as it finds its roots in evidence-based science. It is difficult to draw direct comparisons with other watershed groups and meetings because they are many and varied. Other meetings are commonly organized as an education outreach connected to school curriculum and thus miss some audiences (e.g., post-secondary, government scientists, and policymakers). Meetings run by watershed professional societies (e.g., water-resource engineering) may be too specific and fail to engage citizen scientists.

The MWS encourages and facilitates equitable access to watershed research and provides a setting for expressing concerns. The MWS example is important because the investment comes from the full range of stakeholders, and involvement continues to grow. In the seven years of successful meetings, the formula for the symposium has not changed. The annual meeting includes invited and volunteered oral presentations, and a single concurrent poster session that is interwoven with vendors and displays from participating organizations (Fig. 1). The fact that it is annual is important because stakeholders invest time, build relationships, and add to their knowledge of basin issues.

Participants have diverse interests and expertise: they include politicians, policymakers, local, state and federal government employees and representatives, not-for-profit organizations, researchers (from private, government, and academia sectors), students (elementary, high school, undergraduate, and graduate level) and the general public. Attendance continues to grow, with at least 150 to 180 registered participants in the past three years.

One of the successes of the Watershed Symposium is the direct access to information and the translation and transfer of this knowledge to all stakeholders. Translation involves presenting policy and scientific analysis so that the entire community understands and is able to appreciate the significance. For many, MWS is the primary opportunity to connect with stakeholders in the watershed, and as such, the meeting is integrated into annual outreach programs. Accessibility is maintained with a proceedings volume of extended abstracts produced at each MWS, available to attendees in hard copy and online (http://minerva.union.edu/garverj/mws/2015/symposium.html).

Knowledge transfer includes mentoring and fostering interest in the next generation of watershed scientists and their policy-making counterparts. Increasing student participation and leadership within the MWS is an important objective. Groups with student-driven research include undergraduate and graduate students primarily from local colleges and universities and several other post-secondary institutions in the northeastern United States. Students find that this forum is targeted directly to their research efforts, so interaction can be particularly rewarding due to the interest stakeholders have in their findings. We also encourage participation by high school students and science teachers, many of whom are already associated with the Environmental Study Team from the Schoharie River Center.

From the beginning, the MWS was envisioned as an opportunity to facilitate and foster conversations that drive positive change and expand the understanding of physical processes within the watershed. This success is demonstrated in the breadth and depth of participation and the dynamic nature of the annual meeting. Thus, we highlight the value of community engagement to direct the future of scientific and policy directions in a watershed and hope that the MWS represents a useful illustration of how all the time and effort has paid dividends. Although specific to the Mohawk Watershed, the most important success of the MWS is the least tangible because it has resulted in investment by a wide range of individuals. The orphan of New York State watersheds, the annual symposium has given the Mohawk River an identity, and it has given basin advocates a sense of importance that results in ownership of the basin and its issues. As geoscientists, we play a special role in shaping the dialog and in charting the course, because we have a unique perspective that includes the underpinning science and how that science relates to the public discourse and policy decisions.

Figure 1. Michelle Berube (presently a Kansas State University graduate student) explaining her undergraduate thesis research work to Meghan Haley-Quigley (Union College sustainability coordinator) at the 2015 Mohawk Watershed Symposium. In addition to poster presentations, an important aspect of the symposium is that people have time to talk, interact, and understand the varied issues. Photo by M. Milless.

ACKNOWLEDGMENTS

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