Teaching Geoscience in the Context of Culture and Place

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PREFACE

> *[Our world] is highly diverse in almost all senses—physical, biological, and cultural—and although this produces problems for society and even conflicts and war, would we really want a less diverse and interesting home?...The broad diversity of places, materials, living things, experiences and peoples not only makes the world a more useful and interesting place, but probably also stimulates creativity and progress in a wide range of ways*. (Gray, 2013, p. 4–5).

Across the Earth, an anthropic *cultural landscape* coexists with and interpenetrates the physical landscape (Sauer, 1925). The cultural equivalents of the landforms, hydrologic or oceanographic features, and ecosystems that comprise the physical landscape or seascape are *places*: localities that become imbued with intellectual meaning and emotional significance through human experiences in them (Tuan, 1977). The *sense of place*, a construct well-characterized in theory and research (e.g., Stedman, 2003) incorporates the meanings and attachments we individually or collectively affix to places.

Naming and making places in our physical surroundings is inherent to human nature. The dynamic Earth-system processes (natural and anthropogenic) that form and reconfigure landscapes and environments through deep time have cultural parallels in human actions and events, situated in specific places, that have changed cultural landscapes through human prehistory and history (Schama, 1996). Geoscientific inquiry and exploration are valid, if comparatively recent, examples of these transactions. The activities of geoscientists contribute to place-making, and this includes geoscience education, because we teach in and by means of places. Conversely, our cultural worldviews and experiences—which include our senses of place—directly influence (Lee and Luykx, 2007), and render context and meaning to (e.g., Morton and Gawboy, 2000) the ways that we observe, document, interpret, and teach about Earth features, processes, and history. As they construct factual and conceptual knowledge and skills, geoscience students also leverage and enlarge their senses of the geologically illustrative places that they study (Semken and Butler Freeman, 2008). *Place-based* education (a term introduced by Elder, 1998) refers to an approach that engages the sense of place by emphasizing local and regional surroundings, issues, and knowledge (i.e., place meanings); integrating experiential or service learning in the field or community if possible; foregrounding local relevance; fostering respect and concern for places (i.e., place attachment); and promoting environmental and cultural sustainability.

> *[T]he first way of thinking and knowing has to do with one's physical place. That is, one has to come to terms with where one physically lives. One has to know one's home, one's village, and then the land, the earth upon which one lives…For Indigenous people, this first type of thought begins the extension and integration of connections with Nature and other people in the community*. (Cajete, 1994, p. 47).

Indigenous and other historically rooted groups, communities, and nations typically retain rich and enduring senses of the places of their traditional homelands, whether or not they continue to inhabit these places (e.g., Kelley and Francis, 1994). Their uniquely place-based systems of knowledge, variously referred to as traditional knowledge, traditional ecological knowledge, indigenous knowledge, or indigenous science, incorporate valid and significant geoscientific observations and ideas, which have been referred to as *ethnogeology* (Murray, 1997). And, as attested by the above excerpt from a book by Santa Clara Tewa scholar and science educator Gregory Cajete (1994), as well as by numerous other culturally valid sources (e.g., Kawagley and Barnhardt, 1999; Deloria and Wildcat, 2001), Indigenous philosophies and practices of education are similarly place-based: specifically attuned both to their home landscapes and to the sustainability of their people. This would seemingly predispose students from Indigenous or other historically situated communities (e.g., Native Americans, Native Alaskans, and Pacific Islanders; Mexican-Americans in the Southwest U. S.; African-Americans in the rural South and Southeast U. S.) to pursue studies and careers in geoscience, yet these groups are chronically underrepresented even in comparison to their percentages of the U. S. population (National Science Foundation, 2013). Although many explanations have been offered for this discrepancy (e.g., Velasco and Velasco, 2010; O'Connell and Holmes, 2011), one salient but mostly unexplored possibility is that these students are uninspired or even put off in high school or college by geoscience content and pedagogy that are primarily contextualized by and most relevant to majority Eurocentric or "Western" cultures (Deloria and Wildcat, 2001; Semken, 2005; Chigeza, 2007, Levine et al., 2007; Aikenhead and Michell, 2011).

Place-based and culturally-infused (or culturally conscious) geoscience education, whether presented in formal or informal (free-choice) settings, has been advocated and practiced as a way to better engage historically disenfranchised youth (Chigeza, 2007) and retain Indigenous and

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generationally resident students in and near their homelands and communities (e.g., Riggs, 2005; Semken, 2005; Gibson and Puniwai, 2006; Palmer et al., 2009). In some densely populated urban areas, which have limited geodiversity but are culturally dynamic, place-based geoscience teaching that serves underrepresented minority and immigrant students, as well as pre-service teachers, has been carried out in accessible sites such as green spaces, bodies of water, and museums (Endreny, 2010: Miele and Powell, 2010; Kudryavtsev et al., 2012). These geographically different applications of the approach provide support to Ault's (2008) argument that place-based teaching enhances equity by enriching the senses of place of diverse audiences.

Research on the effectiveness of explicitly place-based teaching of geoscience and environmental science has thus far been limited, and has yielded mixed—though encouraging—results with respect to improved factual and conceptual learning, greater regional and local awareness, enhanced teaching practice, and deeper sense of place (Semken and Butler Freeman, 2008; Endreny, 2010; Williams and Semken, 2011; Kudryavtsev et al., 2012; Clary et al., 2013). While these studies do not constitute unqualified endorsement of the use of place-based teaching in all contexts, they offer an important foundation for continued research and practice.

Indigenous or traditional knowledge may also offer ways to better resolve and interpret changes in Earth and ocean systems than mainstream scientific approaches alone do (e.g., Kimmerer, 2002; Redsteer et al., 2011; Cochran et al., 2013; Beaudreau and Levin, 2014). It is also suggested that traditional knowledge systems are more suited to analysis and interpretation of complex systems than the reductionist approach characteristic of much "Western" science (Iaccarino, 2003; Mazzocchi, 2006; Aikenhead and Michell, 2011). And one frame of reference need not preclude the other: authentic integration of "Western" and traditional science, emphasizing complementary strengths, is also offered as a pathway to more sustainable and scientific environmental and resource management (Murry et al., 2013).

In the interests of intellectual growth and greater equity, diversity, and sustainability, the community of geoscience educators has much to gain from a richer understanding of culture and place, and how to appropriately and effectively engage them in teaching. To this end, the authors and editors offer this two-part special theme issue of the *Journal of Geoscience Education* on Teaching Geoscience in the Context of Culture and Place.

PRESENTING THE THEME ISSUE

Initiated by efforts within the network of Centers for Ocean Sciences Education Excellence (www.COSEE.net), this theme issue highlights new and ongoing efforts to better define, implement, and assess place-based, culturally infused approaches to geoscience teaching. The geographic spread of places identified in these submissions and the range of landscapes, seascapes, and ecosystems discussed indicates that although nascent, the emergence of place-based and culturally infused approaches to geoscience education will likely encompass all Earth systems. The importance of this topic to geoscience educators is evidenced by the number of articles that have resulted: 22 papers distributed over the next two issues of the *Journal*.

The capacity to draw on two systems of scientific knowledge may better enable students to hypothesize and think critically (Semken and Morgan, 1997); and maintaining a dual perspective (e.g., Native and "Western" ways of knowing) may improve the ability of "Western" science to successfully interpret higher orders of complexity in natural living systems (Iaccarino, 2003; Van Regenmortel, 2004). In this regard, actively nurturing diverse cultural perspectives of geoscience and ways of knowing is the subject of two articles in this issue. Lemus et al. (p. 5 of this issue) advocate for an open and inclusive dialogue about the similarities and differences between Western and Hawaiian ways of knowing in courses focused on communicating ocean sciences to broader audiences. Ward et al. (p. 86 of this issue) present a process of cultural validation, in which the cultural expertise and place knowledge of Native American educators and students directly informs development of geoscience assessment tools and methods that are more valid for use with diverse student populations.

Cultural identity, both collective and individual, is fundamentally grounded in language through story, metaphor, and colloquialism (Kirmayer et al., 2011; Mark et al., 2011). Language and culture are so intertwined that loss of one is often accompanied by loss of the other (Harrison, 2007). As the primary means by which place-based knowledge, practices, philosophies, epistemologies, genealogies, and worldviews are shared, language *conveys* culture. Language is also the primary medium by which geoscience knowledge is communicated and a powerful tool for self-reflection and metacognition in geoscience learning. Three thematic papers address the utility of language through writing and discourse as an avenue for exploring and expressing connections between geoscience and culture. Seraphin's (p. 11 of this issue) commentary discusses the importance of writing exercises that help teachers discover students' cultural knowledge, beliefs and scientific conceptions. Wiener and Matsumoto (p. 41 of this issue) then describe a pen pal project designed to help students develop a sense of place while fostering cultural and environmental identities. Finally, Martinez-Álvarez and Bannan (p. 104 of this issue) explore the application of a Third Space construct and the role of language in facilitating bilingual students' understanding of geomorphological processes, making a more robust connection between the practice of place-based education and that of bilingual education.

Physically identifiable spaces such as cities, neighborhoods, parks, or watersheds, provide opportunities for place-based education with otherwise culturally diverse groups through learners' shared experiences with those spaces (Russel-Ciardi, 2006). Three papers in the current issue provide examples of place-based pedagogical approaches to geoscience education in geographically defined spaces at a variety of spatial scales. DeFelice et al. (p. 49 of this issue) describe the use of an urban park as a setting for high-school students to engage in place and inquiry-based explorations of ecological processes in the local environment, while Boger et al. (p. 19 of this issue) use a similar approach for undergraduate students in a major metropolitan area by conducting long-term, place-based, student-led research investigations within the city limits. The scale of place-based inquiry is expanded to entire watersheds by Gill et al. (p. 61 of this issue), offering a cyber-learning tool to investigate the

natural, cultural and economic components of local environmental problems in a student's watershed of choice.

The wider scientific, educational, and conservation communities have become more interested in traditional knowledge over the past two decades (Ford and Martinez, 2000; Mack et al., 2012; Thornton and Scheer, 2012). The integration of "Western" and traditional sciences has also been increasingly referenced in government agency reports as a model for enhanced scientific advancement, sustainable development, environmental stewardship, resource management, and multicultural literacy (CRGAEMP, 2002; BOEM, 2012; NOC, 2013; Vinyeta and Lynn, 2013). Even so, the majority of professional geoscientists and educators have little understanding of the value of traditional knowledge, its cultural context, or how to approach this topic in geoscience education. Professional development workshops can be a valuable tool for developing, sharing and disseminating pedagogical strategies and curricula related to Indigenous knowledge systems. Two articles in the present issue involve the coming together of Tribal staff and leaders, natural resource professionals, scientists, and educators to share "Western" science concepts while incorporating traditional knowledge, culture and practices on the marine environment. Matsumoto and Needham (p. 74 of this issue) describe an annual Tribal Marine Science Workshop in Alaska as a mechanism for providing Western ocean science concepts to coastal Tribal resource managers within a cultural context, and Sigman et al. (p. 25 of this issue) describe three Large Marine Ecosystem Workshops with teacher-scientists teams that produced a web-based collection of culturally responsive teaching resources about the different ocean basins of the northernmost Pacific.

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The *Journal of Geoscience Education* (JGE) is soliciting manuscripts for a themed issue on ***Teaching STEM Principles through Oceanography Content***.

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