Place-based teaching for Earth-system science literacy, sustainability, and sense of place in Arizona and the Southwest

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Earth Science in Arizona and the Southwest (ESAS) is an upper-division place-based Earth-system science course offered to increasingly large and diverse groups of majors and non-majors.

The Geology 301 course is cross-listed in the ASU School of Sustainability as Sustainability 372 to appeal to sustainability science and policy majors for whom an in-depth knowledge of the Southwest is relevant and useful.

ESAS is also a core requirement for pre-service Earth-science education majors, helping all ASU teacher graduates become familiar with the local.

The sole science prerequisite is one college-level geology or physical geography course, opening ESAS to a diverse range of majors.
ESAS is authentically place-based—it’s design, implementation, and assessment are informed by sense of place.

Sense of place encompasses the meanings we make in places and the attachments to places we hold (e.g., Brandenburg & Carroll, 1995). Sense of place is a valid learning outcome and assessment measure for place-based teaching (Semken & Butler Freeman, 2008).
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A place is any locality given meaning by human experience (Tuan, 1977). Places populate the cultural landscape just as landforms, water, and biota comprise the physical landscape (Sauer, 1925).

Cartoon tourist map of central Arizona (Bloodgood, 1950)
ESAS is a narrative connecting the geologic record to the Earth-system processes that formed it, in the Southwestern places where we study it.
ESAS connects the geological evolution of the Southwest to the **nature of its spectacular scenery**.

*Without uplift there would be no Grand Canyon.*

The Colorado Plateau region was lifted high above sea level. The high elevation set the stage for the later carving of Grand Canyon.

**Trail of Time Project (2010)**

Continuing Colorado plateau uplift by delamination-style convective lithospheric downwelling  (2011)

A. Levander, B. Schmandt, M. S. Miller, K. Liu, K. E. Karlström, R. S. Crow, C.-T. A. Lee & E. D. Hauri
ESAS connects the geological evolution of the Southwest to its human history, writ large and small.

Spanish advances (17th Century CE)
General limits of effective Spanish and Mexican control
Present-day remnants of Native American lands

Historical map after Meinig (1971); relief map courtesy of R. Arrowsmith, ASU SESE
ESAS connects the geological evolution of the Southwest to its human history, writ large and small.

“Unless our course changes we shall very soon run into the granite. This gives some anxiety. About nine o’clock we come to the dreaded rock. It is with no little misgiving that we see the river enter these black, hard walls.”

John Wesley Powell (1869)

Paleoproterozoic basement,
Upper Granite Gorge, Grand Canyon, Arizona
ESAS connects the geological evolution of the Southwest to the origin and distribution of its natural resources.

Extensive coastal wetlands

Sevier orogen

Foreland basins

Western Interior Sea

(AZ)   (CO)   (UT)   (NM)

Navajo Coal Mine, northwest NM ... recently purchased by Navajo Nation

Ron Blakey, Colorado Plateau Geosystems (2013)

80 Ma
ESAS connects the geological evolution of the Southwest to **sustainable and unsustainable resource use**.

- **Paleozoic passive-margin sedimentation**
- **Paleozoic limestones (major carbon reservoir)**
- **Cement manufacture in the Southwest**

Built the modern Southwest, but also a major source of **anthropogenic CO₂**.

- Reservoirs in $10^{12}$ kg C
- Fluxes in $10^{12}$ kg C/y

Cockell (2007)
ESAS connects the geological evolution of the Southwest to its natural hazards.
ESAS connects the geological evolution of the Southwest to the public health of Southwesterners.

Ingebritsen & Sanford (1998)

Navajo uranium miners near Cove, Arizona, 1960 (D. Brugge)

Bilingual English-Navajo sign near abandoned Shiprock, NM U-mill site
ESAS connects the geological evolution of the Southwest to challenges to its economic and environmental sustainability.

“Water flows uphill toward money”

Mile-high haboob engulfs Tempe, Arizona
ESAS integrates *indigenous*, *local*, and *global* knowledge.

For example: a comparison of traditional *Diné* (*Navajo*) ideas of *Earth as a system* with the *global Earth system science model* reveals many similarities.

Semken & Morgan, *J. Geosci. Ed.* (1997)
ESAS integrates **humanistic ideas and works** on nature and culture in the Southwest to foster sense of place and contextualize the science.

**music**

**literature**

**art**

**history**

- UV Mine, Jerome, AZ
- Navajo storm-pattern rug
ESAS **field trips** bolster lessons with experiential learning in local natural and built environments, and a regional traverse to Grand Canyon and back.

ESAS students on the Trail of Time, Grand Canyon National Park, Arizona
ESAS will also make increasing use of **Immersive Virtual Field Trips**.

Come explore our iVFTs TODAY!

Explore and study Grand Canyon by iVFT
Bruce, Semken, Anbar, Karlstrom, & Crossey
A Digital Poster Presentation

*Vancouver Convention Centre-West Exhibition Hall C*
*Session No. 2B--Booth# DP7*
*T57. Digital Geology Sandpit I (Digital Posters)*
*Sunday, 19 October 2014: 9:00 AM-5:00 PM*
ESAS students complete a place-based final project in lieu of a final exam. This enables students to express their senses of place creatively—or to share their knowledge with the local community through service learning.
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Thank you! • Ahéhee’ • ¡Gracias!
Much has now been published on creating, teaching, and assessing place-based geoscience curricula for different places and groups.

http://nagt.org/nagt/publications/index.html

**Journal of Geoscience Education**

February 2014 and May 2014 issues
(Volume 62, numbers 1 and 2)
Theme Issue on Teaching Geoscience in the Context of Culture and Place

**In The Trenches**

July 2011 issue (Volume 1, number 3)
Theme Issue on Places of Educational Interest

October 2014 issue (Volume 4, number 4)
Lead article on Restoring a Lost Sense of Place

supports place-based education in the United States with transcontinental resources!
Visit the EarthScope booth #1113 in the Exhibit Hall
and explore
http://www.earthscope.org