

## **Outstanding in the field: Hands-on geophysical education**

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The “Ah-ha” moment of understanding is a great joy for all, but especially for students. Getting to that point in geophysics is a primary goal of our educational programs. More and more evidence suggests that “hands-on” experience or learning by doing are essential ways of developing skills, knowledge, and even creativity (Selingo, 2011). For example, imagine trying to learn to play basketball solely from a textbook while sitting in a desk! Clearly, sports require performance and hands-on practice. Similarly, Chen (2010) suggests that, “Powerful science and mathematics education moves students out of the classroom and into collecting data in fields and streams ....” Edmundson (2011) offers that “we naturally learn by progressing from the concrete to the abstract, not the other way around.” He argues for practical tasks to be in proper phase with theory and that field trips and realistic simulations are critical components of learning. At our 2011 Montana Geophysics Camp, after learning the operation of various instruments and acquiring associated data, we have heard student comments as, “Now, I understand that lecture last year”. While this is a little bittersweet to us, it’s a reminder of the many-faceted and complementary ways that people learn. Education is certainly changing with greater “blending” of on-line materials and face-to-face delivery. The Internet provides access to vast stores of information; but, there are many reasons why the lecture hall continues to be the mainstay of higher education: not the least that people like to spend time together (Yglesias, 2011). But beyond the lecture, lab, and internet lies that other critical component of geophysical learning - field instruction and practice. The Summer 2011 Geophysics Field Camp led by the University of Houston (UH) included 24 undergraduate and graduate students from UH as well as California State University. Instructors were from the Universities of Calgary, Houston, and Texas as well as the energy industry. The School was convened from July 31<sup>st</sup> to August 11, 2011 and its survey sites were centered near Red Lodge, Montana at the Yellowstone Big Horn Research Association (YBRA) facility. The YBRA camp is nestled in the picturesque Beartooth Mountains in an area well endowed with mineral and petroleum resources. The geophysical program was intense with a nine full days of instruction using various instruments, methods, instructors, and sites. Students are encouraged to think about geologic problems and puzzles and how to use geophysical methods to solve them. The participants also see geology at a grand scale. Through their own efforts, they learn to appreciate the work (sweat) that goes into acquiring good data (Figure 1). Other less tangible learnings come from working in teams of diverse members, living in a rustic environment, and interacting with a more natural setting.

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FIG. 1. Students undertake seismic reflection and gravity surveys at the Elk Basin oilfield, Montana.