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Hands-On, Student Geophysical Modelling at the ConocoPhillips School of Geology and Geophysics, University of Oklahoma;

And Much More.

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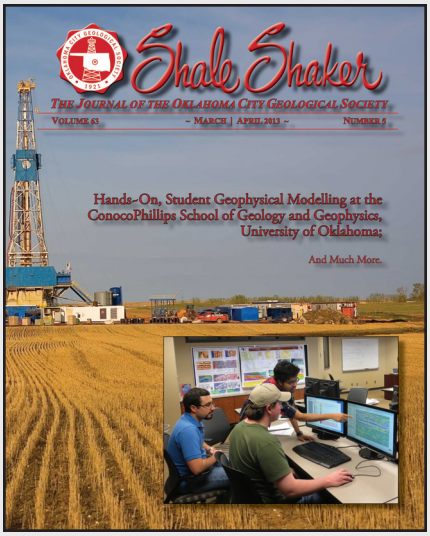
About the Cover

Michael Root creates the covers of the Shale Shaker. His cover for this Issue utilizes a background image of a drilling rig in the Williston Basin active in the Bakken Play. The image came from:

http://www.statoil.com/en/NewsAndMedia/Multimedia/Pages/TheBakkenFormation.aspx

The image in the foreground is of the crustal imaging facility at the ConocoPhillips School of Geology and Geophysics, University of Oklahoma, in Norman. Graduate students Alfredo Fernandez, Ben Dowdell (with cap), and Atish Roy (pointing) are discussing the interpretation of Atish's unsupervised 3D seismic facies classification using a vertical section through the attribute volume near one of the wells in the survey area. The students are co-authors of papers in this Issue of the Shale Shaker.



By: Brittany N. Pritchett, Oklahoma Geological Survey, Mewbourne College of Earth and Energy, The University of Oklahoma, Norman, Oklahoma; Dan S. Ambuehl, ConocoPhillips School of Geology and Geophysics, Mewbourne College of Earth and Energy, The University of Oklahoma, Norman, Oklahoma

Of all the igneous formations in the Wichita igneous province in southwestern Oklahoma, one of the most interesting, bizarre, and beautiful is the Cold Springs Breccia (Figure 1). First termed the Cold Springs Granite by Taylor (1915), this highly variable, intermingled light and dark rock has intrigued and confounded geologists for nearly 100 years, however, few in-depth analyses have been conducted on it. The Cold Springs Breccia is found near Cold Springs, Oklahoma (Figure 2) and traditionally the best exposures are within private quarries. Our favorite outcrop, however, is located at SW¼ NW¼ NW¼ Sec. 8, T. 4 N., R. 17 W. in a very accessible, recently expanded road cut just south of Roosevelt, Oklahoma on US Highway 183.

The Cold Springs Breccia was first systematically studied by Walper (1949) and defined by Powell et al. (1980). The breccia is composed of dark Otter Creek Microdiorite blocks in a leucogranite and aplite matrix. Locally an associated medium-gray intermediate rock forms the matrix, like that in our favorite outcrop. The mineralogy of the microdiorite is primarily plagioclase feldspar and hornblende with some biotite, quartz and clinopyroxene. The granites are primarily composed of plagioclase, quartz and potassium feldspar. The mineralogy of the intermediate rocks is between the two and contains pla-

Figure 1: North –south outcrop of Cold Springs Breccia on the east side of US Highway 183. The road has wide shoulders for easy parking along the outcrop. Do be careful if crossing the street—even though there is not a lot of traffic, vehicles tend to drive very fast in this area.

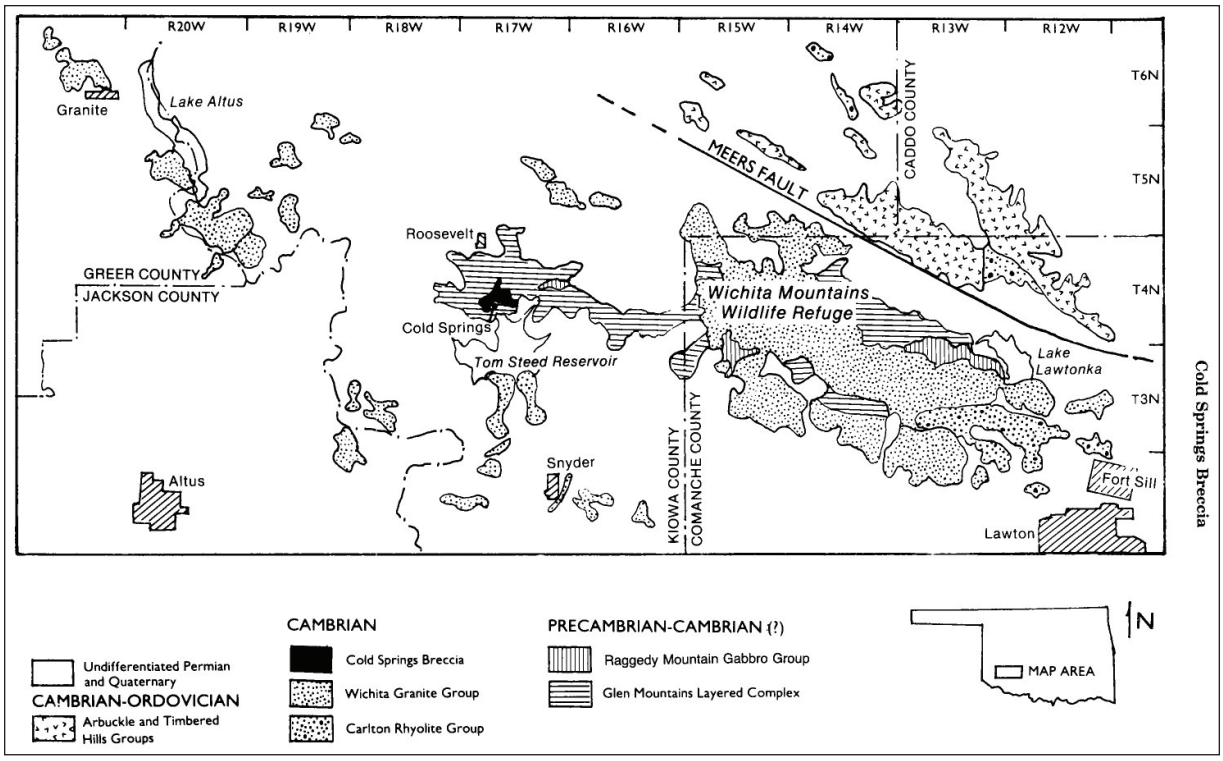


Figure 2. Generalized map of the Wichita Mountains showing the extent of the Cold Spring Breccia (from Vidrine and Fernandez, 1987).

gioclase, quartz and potassium feldspar with biotite and hornblende (Vidrine and Fernandez, 1987). Originally termed a hybrid rock by Walper (1949), the intermediate rock was thought to be a product of an assimilative reaction between the microdiorite and the leucogranite. However, magma-mixing is the most commonly proposed mechanism for the formation of the intermediate rocks. A third origin

Figure 3 . The Otter Creek Microdiorite (seen here in the intermediate matrix) has elongate, rounded shapes. Note that the microdiorites on the left have flattened appearances. Rock hammer for scale.

Figure 4. The microdiorite fragments are much more angular and brecciated than in Figure 3. Rock hammer for scale.

Figure 5, Close-up of the Cold Springs Breccia. The darkest rock shown here is the Otter Creek Microdiorite and the medium-gray matrix is the intermediate rock, which is granodioritic in composition. Both are intruded by late-stage felsic dikes seen here. Note the differential weathering of the more mafic rock versus the felsic rock at the top of the photo. Five-pound sledge hammer for scale.

was proposed by Vidrine and Fernandez (1987), who suggested that the intermediate rocks could be a product of magmatic differentiation.

Textural complexities visible in the outcrop compound the disputed origin of the breccia. One model suggests that there was a near simultaneous intrusion of two magmas (mafic and felsic) (Powell et al., 1980), and a similar model postulates a near simultaneous intrusion of three different magmas (mafic, intermediate, and felsic) (Vidrine and Fernandez, 1987). Another model proposes that either the granitic or the microdioritic material intruded the other while one was still warm in the center, allowing for intrusion brecciation

Figure 6. Large felsic dike intruding Cold Springs Breccia. Rock hammer for scale.

Figure 7. Large quartz crystals surround the microdiorite. It is unknown whether these silicic zones represent the last stage of crystallization of the intermediate rocks or if they originated from a later felsic intrusion along zones of weakness. Rock hammer for scale.

along cooler outer edges and plastic deformation in other areas. The last model suggests that a commingling of magmas occurred before intrusion (Vidrine and Fernandez, 1987). After looking at the textures visible in the Highway 183 outcrop, it is easy to see why its origin is still disputed. Many of the microdiorite inclusions are elongate and rounded (Figure 3), whereas in other places the microdiorite looks broken by the intermediate rock (Figure 4).

Intrusive relationships show that the Cold Springs Breccia is younger than the Raggedy Mountain Gabbro Group but its age relative to the Wichita Granite Group is still uncertain. The Cold Springs Breccia is approximately 514 ± 10 m.y. old (Gil-

Figure 8 . Xenolith of a gabbro from the Glen Mountains Layered Complex within the Otter Creek Microdiorite. Rock hammer for scale.

bert, 1986). Several later felsic and mafic dikes intruded the formation, however, only felsic dikes are visible in this outcrop.

The panoramic photo (Figure 1) was taken of the eastern side of the highway, which is a much better exposure of the Cold Springs Breccia than that on the western side. As you move from north to south along the outcrop, the amount of breccia increases. Late-stage felsic dikes cut the Cold Springs Breccia throughout the outcrop (Figures 5 and 6). In some areas there are large quartz crystals surrounding the microdiorite (Figure 7). It is unknown whether these silicic zones represent the last stage of crystallization of the intermediate rocks or if they originated from a later felsic intrusion along zones of weakness. Also seen at this outcrop is an uncommon xenolith of the Glen Mountain Layered Complex country rock within a piece of the Otter Creek Microdiorite in the northern part of the exposure (Figure 8).

Be careful viewing the outcrop during late spring, summer, or early fall, as rattlesnakes are common. If looking for more to do in the area, this outcrop is only about one hour away from Quartz Mountain State Park to the northwest and the Wichita Mountains National Wildlife Refuge to the east.

Acknowledgements

We would like to thank Dr. David London for introducing us to this outcrop and for providing valuable insight. We would also like to thank Dr. Charles Gilbert for reviewing an earlier manuscript of this article, helpful discussions and advice and Dr. Neil Suneson for helpful discussions.

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Brittany N. Pritchett

Biographical Sketch

Brittany Pritchett is a petroleum geologist with the Oklahoma Geological Survey as well as the manager for the Devon X-Ray Diffraction laboratory at the University of Oklahoma ConocoPhillips School of Geology and Geophysics. She is currently working on creating a comprehensive field trip guide of Oklahoma and is a co-investigator on a newly funded NASA grant to further investigate mineral dissolution in saturated brines, specifically in relation to Mars. Brittany is from Oklahoma City, Oklahoma. She received her B.S. degree in Geology from the University of Oklahoma in May 2010 as well as her M.S. degree in May 2012.

Dan S. Ambuehl

Biographical Sketch

Dan received his B.S. in Geology from the University of Oklahoma. He is currently completing a Master's degree in Geochemistry studying the effects of CO_2 bubbles on the gas hydrate formation and dissociation rates. He is a member and past president of the Pick and Hammer Club. He presented his thesis work at the American Geophysical Union annual conference in December 2012. He has accepted a job with EOG Resources, Inc. in Oklahoma City starting July 2013.

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