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ON THE COVER
Michael Root created the cover of this Issue of the Shale Shaker. His cover artwork utilizes a photograph taken by Jonathan C. Wheeler, and frames Mt. Sheridan in the Wichita Mountains of southwestern Oklahoma. For more photographs of the Wichita Mountains, and others by Mr. Wheeler, please visit:

www.panoramio.com/user/1974470?with_photo_id=27230305

The cover photograph ties nicely with the article within this Issue authored by M. Charles Gilbert and John P. Hogan, “Our Favorite Outcrop: The Striking But Enigmatic Granite-Gabbro Contact Of The Wichita Mountains Igneous Province.”

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INTRODUCTION

One of the most visible and spectacular regional outcrops in the southern midcontinent is the granite-gabbro contact in the eastern Wichita Mountains of southwest Oklahoma (Fig. 1). Almost all visitors to this area, if they look closely at the topography, will notice a distinct curvilinear vegetation change that tracks this profound lithologic contact. After pointing out the best places to view the granite-gabbro contact, we will discuss the contact relationships and their geologic importance in advancing our understanding of the Wichita Mountains igneous province. Resolving the exact nature of this contact has been a challenge. Thus, there are still opportunities for new and continued research on this contact’s significance.

VIEWING THE OUTCROP

Almost everywhere this granite-gabbro contact is exposed, a vegetation contrast delineates it. The more wooded, highly vegetated lower surface is underlain by gabbro while the upper less-wooded, less-vegetated surface is underlain by granite. Everywhere this can be seen, gabbro is on the bottom, and granite is on top. Perhaps the easiest place to see the regional contact is from highway OK 58, running generally north-south, along the eastern side of Lake Lawtonka (Fig. 2). Looking west from this highway, about 3 miles north of its intersection with highway OK 49, one has a sideways view of the main west-northwest igneous front of the interior Wichitas. Mt. Scott is prominent in the foreground just across the lake. The distinct, well-treed lower slopes represent the gabbro, while the upper, somewhat more rocky-appearing and less treed, slopes are the granite. The contact dips about 15° south along the east side of Mt. Scott (Fig. 3). However, looking on the north side of Mt. Scott, and then on west, one can follow the contact easily across Mt. Wall and past Mt. Sheridan to Tarbone Mountain. Finally, this view can also be well seen from the Meers area. In many ways, it is a really spectacular view when you understand the lithologic and geologic consequences.

If one drives up the Mt. Scott road to the top, the regional views of Wichita Mountains geology, in all directions, are impressive. However, the western view is dominated by Mt. Sheridan where, once again, one sees the prominent vegetation change with gabbro below and granite above. Note again, the roughly 15° dip to the south. As the road up Mt. Scott starts in granite and remains in granite all the way to the top, the granite-gabbro contact on Mt. Scott itself is not obvious from this road (Fig 3). However, as one drives west from Medicine Park on highway OK 49 toward the east entry to the Wichita Mountains Wildlife Refuge, the contact can again be easily seen dipping south toward the viewer along Scott’s east side.

Google Earth views of the Wichita Mountains area show this prominent contact. While not so immediately obvious to many from the ground, this contact is pronounced along the north side of the Refuge’s Interior Lowland from the...
Quanah Parker Lake area to the Panther Creek area; and also along the south side of the Lowland from Quanah Parker Lake to the Osage Lake parking area. Farther west, at the west end of the Wildlife Refuge, this contact shows beautifully in Hollis Canyon (but harder to see here unless on a guided tour as this is in the Refuge’s restricted area) (Fig. 4), and in the Mt. Baker-Cutthroat Gap area. The latter contact area is clear looking east from highway OK 54 (near its junction with OK 19). The lower slopes are underlain by gabbro, and the tops of the peaks by granite.

**GEOLOGY OF THE CONTACT**

Now that we have established the viewing areas, let us describe the stratigraphic units forming this contact and its significance (Fig. 5). The granite unit on the top is the Mount Scott Granite, the most widespread of the granite units in the Wichitas, and one of the oldest. This unit has been dated at

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**ABBREVIATED LITHOSTRATIGRAPHY OF THE EASTERN WICHITA MOUNTAINS**

**EARLY CAMBRIAN**

<table>
<thead>
<tr>
<th>Wichita Granite Group</th>
<th>Quanah Granite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount Scott Granite</td>
<td></td>
</tr>
<tr>
<td>Carlton Rhyolite Group</td>
<td>Bally Mountain Section</td>
</tr>
<tr>
<td>Blue Creek Canyon Section</td>
<td>Fort Sill Section</td>
</tr>
<tr>
<td>Roosevelt Gabbros</td>
<td>Mt. Baker Gabbro</td>
</tr>
<tr>
<td>Mt. Sheridan Gabbro</td>
<td>Sandy Creek Gabbro</td>
</tr>
</tbody>
</table>

Glen Mountain Layered Complex

While these units are listed generally from oldest at the bottom to youngest at the top, geologic relations discussed in the text show that these Roosevelt Gabbros may be nearly the same age as the Mount Scott Granite or even slightly younger.
534 +/- 1.5 Ma by Hogan, Wright, and Gilbert, by U-Pb methods on zircon and is the best-dated rock unit in the Wichitas. Because it is a “sheet” granite, its outcrop pattern is somewhat similar to a normal sedimentary unit (Hogan and Gilbert, 1997). This granite shape tells us something about its tectonic setting, having been emplaced in a Cambrian rift zone called the Southern Oklahoma Aulacogen. Thus it formed in an extensional environment quite dissimilar to the bulbous granites of the Sierra Nevada.

The underlying gabbros belong to the Raggedy Mountains Gabbro Group. It is important to note that there are two compositionally and temporally distinct gabbros below the Mount Scott Granite. The oldest gabbro, and the one underlying granite in the Central Lowland of the Refuge and west of the Tarbone Mountain area, is the Glen Mountains Layered Complex (GMLC). This is the oldest igneous rock cropping out in the Wichita Mountains. At one time, this layered gabbro complex was thought to be associated with mafic magmatism of the 1.1 Ga Midcontinent Rift. However, a Nd/Sm whole rock-mineral isochron yielded an age of 528 +/- 29 Ma for the GMLC that clearly established this magmatism as part of the Cambrian rifting event (Lambert et al., 1988). A more precise estimate of the age of crystallization is clearly needed. This unit has the largest outcrop area of the gabbros and also underlies much of the mountainous topography in the Roosevelt area. Another set of gabbros called the Roosevelt Gabbros, make up the rest of the substrate gabbros. The Roosevelt Gabbros are demonstrably younger than the GMLC (e.g., Powell and Fischer, 1976; stops in Gilbert and Donovan, 1982) and form smaller plutons.

The Roosevelt Gabbros also underlie the Mount Scott Granite sheet. These contacts are also well exposed in a regional sense at several localities. In the Mt. Sheridan area, the Mt. Sheridan Gabbro crops out beneath the Mount Scott Granite. A 40Ar/39Ar laser probe study of primary biotite and amphibole from the Mt. Sheridan Gabbro yielded ages of 533 +/- 4 Ma and 533 +/- 2 Ma, respectively (Hames et al., 1995). The close agreement between these two mineral ages is consistent with rapid cooling of a shallow-level intrusion and is interpreted to represent the crystallization age of this pluton. However, Bowring and Hoppe (1982) previously interpreted an age of 552 +/- 7 Ma for the Mt. Sheridan based on a U/Pb study of zircons. These conflicting results highlight the problematic nature of the contact between the Mt. Sheridan Gabbro and the Mount Scott Granite. In the Hollis Canyon area, a separate, but related gabbro called the Sandy Creek Gabbro underlies the Mount Scott in that area. Then in the Cutthroat Gap area, underneath the Mount Scott Granite, there are two gabbros: the GMLC and the Mt. Baker Gabbro, another member of the Roosevelt Gabbro Group. So, we have one granite unit that is well dated, the Mount Scott, that overlies all the granite-gabbro contacts, but it sits on different gabbros in different places with different ages. What does this mean?

**GEOLOGIC SIGNIFICANCE OF THE CONTACT**

First, some history: W. E. Ham, R. E. Denison, and C. A. Merritt in 1964 laid the groundwork for understanding the geology of the Wichita Mountains area and what came to be known as the Southern Oklahoma Aulacogen (although they did not develop the aulacogen, or rift, concept for this region). From their studies, and most of the work since, it appeared that the gabbroic rocks were the oldest, had been unroofed by subsequent erosion, and then covered again by rhyolitic lavas (e.g., Carlton Rhyolite Group). The nature of the rhyolite-gabbro contact has been inferred from regional relationships and has yet to be directly observed in the field or in drill core. Following the rhyolite, the rise of some silicic magmas intruded along the rhyolite-gabbro contact to crystallize as granites, and generating the granite-gabbro contact. Thus the rhyolite-gabbro contact was originally an unconformity that was modified later by intrusion of the sheet granites, the gabbro being older and the granite younger. This led to the perception that most of the basaltic magmas were distinctly earlier than the rhyolitic/granitic ones, requiring a rather profound change in igneous chemistry, separated by a period of uplift and substantial erosion. However, detailed lithostratigraphic relations of the igneous rock units had not yet been worked out. It was not until 1980, that B. N. Powell, M. C. Gilbert, and J. F. Fischer provided the present framework in which the igneous rock units are now understood. One example of the change in understanding was that Ham et al. (1964) had not recognized that there were different, distinct, and mappable gabbros(both the Roosevelt Gabbros and the Glen Mountains Layered Complex) in the “gabbro” below the granite-gabbro contact.

After the Roosevelt Gabbros were recognized and separated out from the older Glen Mountains Layered Complex, it was still thought by most that the gabbros were all distinctly older than the Mount Scott Granite. However, J. P. Hogan and W. E. Hames dated the Mt. Sheridan Gabbro by
argon-argon methods (as noted above) and discovered that this gabbro’s age was essentially radiometrically indistinguishable from that of the Mount Scott. Almost concurrently, J. D. Price, J. P. Hogan, and M. C. Gilbert discovered that the intrusive character and shape of the Sandy Creek Gabbro (another member of the Roosevelt Gabbros) could be interpreted as having intruded up against the Mount Scott Granite (Price et al., 1998). They postulated that the “hybrid rock” that locally occurs along the contact between the Mount Scott and the Sandy Creek may have an origin as partially melted Mount Scott Granite, with the heat source being the Sandy Creek Gabbro. So rather than being older than the Mount Scott, it is possible that some of the Roosevelt Gabbros are younger.

J. P. Hogan and students have been working on the crystallization history of the Mt. Sheridan Gabbro to try to determine the detailed interaction with the overlying Mount Scott Granite. This contact is exposed along “Little Mt. Sheridan”. Here the Mount Scott Granite overlies the Mt. Sheridan Gabbro. Locally, hybridized granite-gabbro intervenes along the contact between these two units (Fig. 6). The hybridized rock contains abundant enclaves, many of which are mafic with sharp contacts, perhaps fragments of dikes, whereas others have irregular cuspeate-lobate margins more indicative of magma mingling (Fig. 7). In addition, petrographic analysis of the gabbro shows distinct fining of grain size and loss of cumulate textures as the contact is approached. So was the Mount Scott Granite already there when the Mt. Sheridan was emplaced, or had it just been emplaced, or could they have been emplaced nearly simultaneously? A definitive answer is not yet forthcoming.

It is still clear that at the Mount Scott Granite-Glen Mountains Layered Complex contact, the gabbro is older, and the original interpretation would still hold, that this is an unconformity along which the Mount Scott Granite intruded. But now the possibility exists that the Roosevelt Gabbros are nearly contemporaneous with, and possibly younger than, the Mount Scott. This makes that part of the granite-gabbro contact where the gabbro is one of the Roosevelt Gabbros, a totally different kind of contact. Hogan and Gilbert (1995) have called this sort of boundary a “crustal magma trap” and it would seem to nicely apply here. The balance of magma driving pressure, the water content of these particular gabbroic liquids, and height in the crust from the deeper Roosevelt Gabbros comes up against the mechanical properties of a perhaps already existing layer of Mount Scott Granite (see Hogan et al., 1998). This granite layer then forms a blockage to the gabbroic magma moving on up in the crust.

CONCLUSION

Obviously we have a striking contact, with profound importance for understanding the igneous history of the Wichita Mountains (i.e., Southern Oklahoma Aulacogen), that in places is still problematic. The contact beckons further work on its characterization and timing of events. This contact is surely one of the most important of the igneous contacts to be seen in Oklahoma. From the viewer’s point, it is one of the easiest and most distinct contacts to be seen in the Midcontinent. When you are in southwest Oklahoma in the Wichita Mountains region, look for it.

*Missouri University of Science & Technology Contribution 20

References


M. Charles Gilbert

M. Charles Gilbert was born and grew up in Lawton, OK near the Wichita Mountains. His love of geology was nurtured by a high school geology class, and by climbing around in the Wichitas. He graduated from OU with a BS in 1958, and an MS in 1960. The MS was a field study of the mafic igneous rocks near Roosevelt, OK under Hugh Hunter. Subsequently he went to UCLA for a PhD (1965) under Gary Ernst with a lab-oriented experimental dissertation on hornblende geochemistry. Before leaving UCLA, he also worked with Ernst on the Franciscan mélangé of the California Coast Ranges, and the Sanbagawa terrain in Japan. He spent three years as a Post-Doc at the Geophysical Laboratory in Washington, DC; 15 years teaching at Virginia Tech; seven years teaching at Texas A & M (with three years at the U.S. Dept of Energy, Basic Energy Sciences division in Germantown, MD); and 17 years teaching at OU (eight and one-half years as Director), retiring in 2007. He re-ignited his interest in the Wichitas in 1977-78 when on a sabbatical from Virginia Tech to the Oklahoma Geological Survey. He has concentrated his research on the Wichitas since then.

John Hogan

John Hogan received a B.S. in Geology from the University of New Hampshire, and an M.S. (1984) from Virginia Tech under David Wones on Maine igneous geology, and a Ph.D. (1990) from Virginia Tech under A. Krishna Sinha on more Maine igneous geology. He spent 1990-1998 at O.U. as a Research Associate working on the Wichita Mountains with Charles Gilbert and Jon Price, and has been a faculty member at Missouri University of Science & Technology at Rolla ever since. There he teaches field camp, structure, and igneous geology. His research areas, besides the Wichitas, include coastal Maine geology and structure in Egypt.