reflect differentiation in the intrusion. They should not be confused with hydrothermally altered gabbro, common in sec. 4, which probably was altered in response to granite emplacement. (See more on this below.) Differentiation of the Sandy Creek Gabbro is further reflected in the range of bulk compositions (table 30) and in systematic phase chemical variations (cryptic variation) (figs. 115, 117).

Exposures in the eastern half of sec. 4, T. 3 N., R. 15 W., reveal intrusive relationships that are a key to the relative age of the Sandy Creek Gabbro. Meter-sized xenoliths of unaltered gabbroic anorthosite of the Glen Mountains Layered Complex occur in the Sandy Creek Gabbro (fig. 106A), fixing the younger age of the latter. In addition to the granite contacts referred to above, a north-trending aplite dike approximately 2 m wide can be traced for about 250 m in the eastern half of sec. 4 (fig. 106A). Over much of the meadow east of this dike are low, discontinuous outcrops of gabbro and banded granite pegmatite, the latter containing riebeckite–arfvedsonite ± aegerine. Many exposures of the gabbro are relatively light in color in comparison with its more typical appearance (almost black) and locally resemble gabbro pegmatite. This material, in thin section, is seen to be rather pervasively altered. Plagioclase is variably replaced by sericite, calcite, and "clays"; original mafic phases are totally altered to mixtures of pale green, acicular to fibrous amphibole, chlorites, calcite, epidote–zoisite minerals, and traces of sphene (fig. 118).

Feldspar grain boundaries are highlighted in the outcrop by the alteration, which also lightens the color of the matrix (originally interstitial or ophitic mafic minerals). These effects impart a (basic) pegmatitic appearance to the coarse-textured altered gabbro, although fine- to medium-grained rocks are locally altered also. The grain-size variation in the Sandy Creek Gabbro appears to be primary and does not in any obvious way correlate with the alteration process.

Although the alteration, together with observed and inferred contact relations, fixes the age of the Sandy Creek Gabbro relative to the younger Wichita Granite Group, the observed alteration patterns and contact relations have wider relevance. Similar rocks are found elsewhere in the Wichita province where the precursors belong to lithostratigraphic units other than the Sandy Creek Gabbro. In the vicinity of Meers, Oklahoma, and in the central portion of the Wichita Mountains Wildlife Refuge, outcrops of the Glen Mountains Layered Complex are similar in alteration and appearance to the altered, coarser grained Sandy Creek Gabbro (see figs. 2 and 7 for

TABLE 28.—ANALYSES OF AMPHIBOLES IN SANDY CREEK GABBRO

	1		2		3	
	WM-152		WM-337		WM-309	
SiO_2	43.2		45.3		43.8	
TiO_2	3.42		2.08		2.60	
Al_2O_3	10.7		8.78		9.96	
Fe_2O_3	1.99		2.14		2.02	
FeO	10.2		11.0		10.3	
MgO	13.6		14.8		14.6	
CaO	11.3		11.7		11.4	
Na_2O	1.84		1.54		2.19	
K_2O	1.08		0.67		0.76	
SUM+	97.33		98.01		97.63	
Si	6.367	8.000	6.618	8.000	6.434	8.000
Al^{iv}	1.633		1.382		1.566	
Al^{vi}	0.218	5.000	0.132	5.000	0.161	5.000
Fe^{3+}	0.221		0.236		0.223	
Ti	0.379		0.229		0.288	
Mg	2.994		3.222		3.198	
Fe^{2+}	1.188		1.181		1.130	
Fe^{2+}	0.064	2.000	0.158	2.000	0.133	2.000
Ca	1.789		1.840		1.789	
Na	0.147		0.002		0.078	
Na	0.379	0.583	0.434	0.559	0.546	0.689
K	0.204		0.125		0.143	
$Mg/(Mg+Fe^{2+})$	0.705		0.706		0.717	

NOTES TO TABLE

*Fe_2O_3 CALCULATED ASSUMING $Fe^{3+}/(Fe^{3+}+Fe^{2+}) = 0.15$

+ANALYSES ARE BY MICROPROBE AND DO NOT INCLUDE H_2O, F, Cl.

ANALYSES (AVERAGES OF SEVERAL IN EACH SAMPLE):

1. TITANIAN MAGNESIO-HASTINGSITIC HORNBLENDE FROM OLIVINE GABBRO (WM-152). OLIVINE Fo_{68}.
2. EDENITIC HORNBLENDE FROM OLIVINE GABBRO (WM-337). OLIVINE Fo_{66}.
3. TITANIAN MAGNESIO-HASTINGSITIC HORNBLENDE FROM OLIVINE GABBRO (WM-309). OLIVINE Fo_{67}.