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Keith E. Anderson
Iowa Geological Survey

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Basement Complex Biotite Granite at Dubuque, Iowa [1]

By Keith E. Anderson

Introduction

The city well No. 8 at Dubuque, Iowa penetrated slightly more than 15 feet of the upper part of the crystalline pre-Cambrian basement complex. This well is of particular interest because it is the southeasternmost of the 15 wells in Iowa known to reach the crystalline basement, and because samples from the well were sufficiently large to permit preparation of thin sections for petrographic examination.

The well was drilled in 1946 to a depth of 1,781.7 feet by the Varner Well Company of Dubuque. Drilling was by the cable-tool method. The well is located on the floodplain of the Mississippi River at CSL SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 7, T. 89 N., R. 3 E. The surface altitude is 610 feet.

A generalized log of the well is as follows:

Geologic Unit and Description	Thickness (feet)	Depth (feet) From	Depth (feet) To
Pleistocene system			
Alluvium (sand and gravel)	140	0	140
Ordovician system			
St. Peter formation (sandstone)	199	140	339
Prairie du Chien formation (cherty dolomite, sandstone, red and green clay shale)	66	339	405
Cambrian system			
Trempealeau formation			
Jordan member (sandstone)	75	405	480
St. Lawrence member (dolomite)	90	480	570
Franconia formation (dolomitic, glauconitic siltstone and sandstone)	160	570	730
Dresbach formation (sandstone, dolomitic and silty in middle part)	495±	730	1225±
Pre-Cambrian (?)			
Red Clastics (?) (reddish arkosic sandstone, silty in part)	540±	1225±	1765
Pre-Cambrian			
Biotite granite	16.7	1765	1781.7

Petrography

Samples of the granite comprise loose grains of quartz, pink and gray feldspar, and black biotite. A few larger rock chips, one cen-

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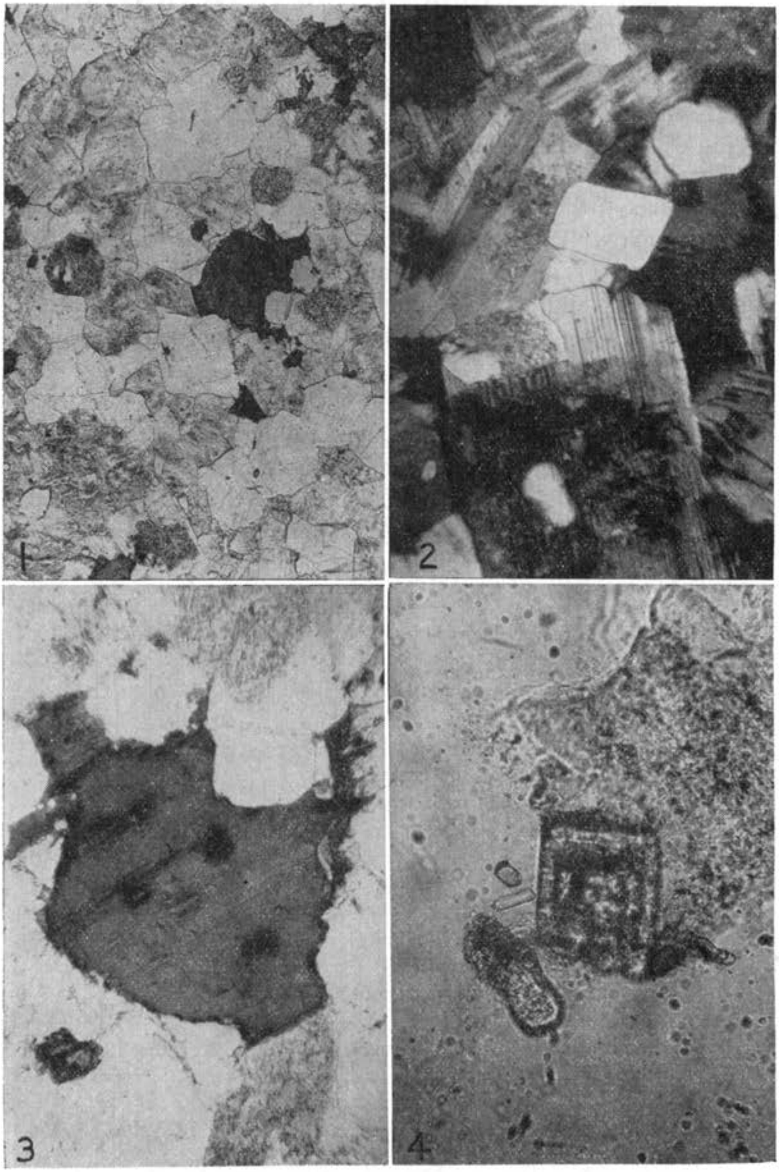

Fig. 1. Hypidiomorphic-granular texture in biotite granite. X18.

Fig. 2. Zoned plagioclase, microcline, and quartz. Nicols crossed. X53.

Fig. 3. Embayed crystal of biotite. X63.

Fig. 4. Zircon crystal showing zoning. X380.

timeter or more across, were obtained from a depth of 1,775 feet and two thin sections were made from these chips.

The rock is fine grained, individual grain diameters ranging from 0.2 to 0.7 millimeters with an average of about 0.4 millimeters. The texture is hypidiomorphic-granular (fig. 1). Alteration has affected certain minerals, chiefly the feldspars. A few of the larger chips suggest that weathering of the upper part of the granite has been slight except along joints or fractures.

The mode, as determined by the Rosiwal method, is as follows:

Quartz	40 percent
Oligoclase	26
Orthoclase	15
Microcline	12
Biotite	7
Accessories	Less than 1

These percentages should be considered approximate as only one thin section was suitable for micrometric study.

The rock is considered to be a biotite granite and is assigned to the 226P (or 226″P) granite subdivision of Johannsen's classification. The name adamellite is not used because the ratio of alkali to lime-alkali feldspar could not be determined with sufficient accuracy from the samples available.

Mineral Descriptions

The minerals present include the following, listed approximately in order of abundance:

Primary			Secondary
Essential	Varietal	Accessory	
Quartz	Biotite	Zircon	Clay minerals
Oligoclase		Apatite	Sericite
Orthoclase		Magnetite	Chlorite
Microcline		Fluorite	Magnetite
			Hematite
			Titanite ?

Quartz. Quartz occurs in anhedral crystals containing small fluid bubble inclusions. Quartz embayments and small included blocks of quartz are present in plagioclase and biotite. Some of the quartz shows slight undulatory extinction.

Plagioclase feldspar. The plagioclase feldspar occurs as subhedral or anhedral crystals of oligoclase having a composition of approximately $Ab_{85}An_{15}$. Some of the crystals show zoning with the outer zones richer in albite. Oligoclase crystals, also, may be embayed by quartz. Most of the oligoclase has been partly altered to clay minerals and sericite, but some hematite has been formed. Alteration is most intense on the cores of zoned crystals (fig. 2). Both albite and Carlsbad twinning are present although the Ab-An ratio is such that some twinning is difficult to recognize.

Potash feldspar. Orthoclase and microcline occur as anhedral crystals somewhat altered to clay minerals and sericite. The alteration, however, is not usually as pronounced on the potash feldspars as on the plagioclase.

Biotite. Prismatic sections of biotite show almost no deformation. The rims of the crystals often show alteration to magnetite or hematite and in some cases part or all of the biotite has been altered to a bright green chlorite. Small euhedral inclusions of zircon surrounded by dark halos are rather common, and some of the biotite has been embayed by quartz (fig. 3). Pleochroism is strong with $X =$ light yellow or green and $Y = Z =$ dark green or brown to opaque. The axial angle is nearly zero.

Accessories. Zircon occurs as small euhedral crystals, many of which are zoned (fig. 4). Apatite is scattered throughout the rock in small euhedral to subhedral crystals having an average diameter of 0.06 millimeters. Magnetite is present as a primary accessory mineral in euhedral grains up to 0.2 millimeters in diameter, and in smaller secondary grains along the rims of altered biotite. A few scattered crystals of colorless to purplish fluorite are present.

Secondary minerals. The feldspars show alteration to a clay mineral and sericite. The chlorite is usually a bright green and is secondary after biotite. One grain of biotite shows alteration to a mineral which may be titanite. Hematite is present as a thin film on feldspar and as an alteration of magnetite.

Iowa Geological Survey
Iowa City, Iowa