In addition to the results just mentioned, which suffice to clear up the liquidus relations in question, as thorough an investigation as the nature of the problem and the available methods of attack would permit was carried out upon the solid solutions of silica and $3\text{CaO} \cdot 2\text{SiO}_2$ in calcium metasilicate and upon the inversion and decomposition temperatures of all the various solid solutions.

A general discussion of these results with diagrams and models is given. The formation of unstable phases in silicate melts is also discussed, and the futility of attempting to use formulae derived from the theory of dilute solutions in order to calculate the change of inversion temperature with solid solution is briefly mentioned.

Geophysical Laboratory,
Carnegie Institution of Washington,
June 1, 1919.

ART. XII.—*The Extent and Interpretation of the Hogshooter Gas Sand*,¹ by WALTER R. BERGER.

The Hogshooter gas sand is the producing horizon of the field of the same name. This field is about twelve miles in length, and from one to one and one-half miles in width, extending north from the west-central part of Township 24 North, Range 14 East, Washington County, Oklahoma.

The Hogshooter gas sand lies directly upon the Boone Formation, which is a cherty limestone of Mississippian age, underlying this region at a depth ranging from 1200 to 1400 feet. The sediments immediately above this sand in this locality, the Cherokee shale, are considered Pennsylvanian age. The sand varies greatly in thickness and pinches out at only a short distance to the east and west of the long axis of the field. The greatest thicknesses recorded in well records are near the center of the productive area. The maximum thickness recorded is 168 feet in well number 3 on the Taylor allotment in Section 18, Township 24 North, Range 14 East.

The sand horizon has been determined by means of several hundred records of wells drilled in this region, to

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be a continuous body of sand in a north-south direction, but very narrow and lenticular in the opposite direction. To the north it is productive in the Burgess oil field, located at the corner of Townships 26 and 27 North, Ranges 13 and 14 East. The Burgess field extends in a southeast-northwest direction and is about four miles in length. North of this oil field the sand is productive of gas in scattered wells, and in the small gas field two miles east of Copan, Oklahoma. Five miles farther north, the Vander Pool produced from this sand. This field compares with the Hogshooter field in its shape which is long and narrow, extending northward from Section 34, Township 29 North, Range 13 East, into Kansas.

To the south of the Hogshooter gas field the sand is not so easily determined as it is to the north. This is due principally to two causes. Firstly, the reliable well records of this area are scarce. Secondly, the Cherokee shale and the Boone formation diverge² to the south and other beds come in between them. These intermediate beds thicken rapidly to the south, making it difficult to trace individual horizons in the well logs.

However, from the data available, it is considered that the Hogshooter sand takes an almost due south course. It is certainly the producing sand in the small oil field in the southwest corner of Township 23 North, Range 14 East. Six miles farther south a small gas field in Sections 35 and 36, Township 22 North, Range 13 East, and the oil field in the southwest corner of Township 22 North, Range 14 East, produce from this sand. The large gas field in the north central part of Township 21 North, Range 14 East, produces from a thick sand that seems to be the Hogshooter sand, even though the few good records show a thick shale to be present between the sand and the Boone formation.

As before mentioned the Hogshooter sand is very narrow. Throughout most of its extent it varies from one to five miles in width. Locally there are narrow extensions westward and eastward from the main body. In the Hogshooter Gas field the sand has maximum recorded thickness of 168 feet, but does not appear in the logs of wells drilled four miles to the west and three miles to the east. In the Burgess oil field, where the axis

² Relation of the Ft. Scott Formation to the Boone chert of S.E. Kansas and N.E. Oklahoma, *Journal of Geology*, vol. 26, 7, p. 619.

East - West Cross Section
HOGSHOOTER GAS FIELD

EXTENT OF HOGSHOOTER SAND

Solid lines represent extent of sand.

Dashes represent outline of Oil or Gas Fields.

Crosses denote location of wells in which sand was not found.

extends nearly southeast-northwest, the thinning is even more rapid, from a thickness of at least 70 feet in wells near the center of the field to zero in wells one mile to the north and one-half mile to the south. Likewise in the Vander Pool the sand thins from about 100 feet to zero in one mile to the east and in but a little greater distance to the northwest.

The known locations of the eastward and westward extensions from the main body are as follows:

(1)	Section 32 and 33	T. 28 N., R. 13 E.	Max. thickness 34 ft.
(2)	" 32	T. 27 N., R. 13 E.	" " 17 "
	" 5	T. 26 N., R. 13 E.	" " "
(3)	" 32	T. 28 N., R. 14 E.	" " 31 "
	" 17	T. 27 N., R. 14 E.	" " "
(4)	" 32	T. 24 N., R. 13 E.	" " 42 "
	" 6	T. 23 N., R. 13 E.	" " "

There are probably other extensions which have not been shown by the drilling. This is especially true of the southern part of the area, but as previously stated the sands there cannot be readily traced.

Two wells have been drilled by the Empire Gas & Fuel Company, one in the Vander Pool and the other in the south end of the Hogshooter gas field, from which very complete sets of cuttings were taken. A study of these cuttings show that the Hogshooter gas sand is a light-colored sand, composed of rounded quartz grains, with a very small amount of muscovite, pyrite, and dark colored minerals. The size of the grains varies from 0.2 to 0.3 millimeters in the Hogshooter field, and from 0.3 to 0.6 millimeters in the Vander Pool.

All available data, especially the shape, thickness and irregular lenticularity of the sand in the east-west direction, lead to the conclusion that the Hogshooter gas sand must be the sand deposited by a large river along its course. This conclusion is strengthened by the fact that there was, at the time the sand was deposited, a topographical depression (which is interpreted as being an old river valley) in the area where the sand body is found. This depression extended north and northwestward as a trough which was present immediately prior to or during the early part of the deposition of the Cherokee shales. This topographical depression or trough is evidenced by the great thicknesses of the Cherokee shale

along this belt, in comparison with the thicknesses to the east and west. A stream coming from the region to the east of the granite hills of Kansas, which were undergoing erosion at this time, would come through this depression on its way to the pre-Cherokee basin, which lay to the south and east of the area under consideration.

The main body of the Hogshooter gas sand is interpreted as having been deposited in the channel of the principal stream flowing southward through the pre-Cherokee valley. The narrow and comparatively thin eastward and westward extensions of the Hogshooter sand are believed to be deposits made by tributary streams, in the lower part of their courses.

Similar deposits are known at the surface in central and northern Missouri, where two main channels have been mapped³ as the Warrensburg and Moberly Channels. These channels and their tributaries were made by streams flowing to the north and west from the old land mass in southeast and central Missouri. These channels were formed considerably later in Pennsylvanian time than the deposit just described, and at the time of their formation, the depositional basin had expanded far to the northward and westward.

The writer is indebted to Mr. A. W. McCoy, under whose direction the work has been carried on, and also to Dr. L. C. Snider, for valuable suggestions.

³ Missouri Bureau of Geology and Mines, 2d Series, vol. 12, pp. 91-106.