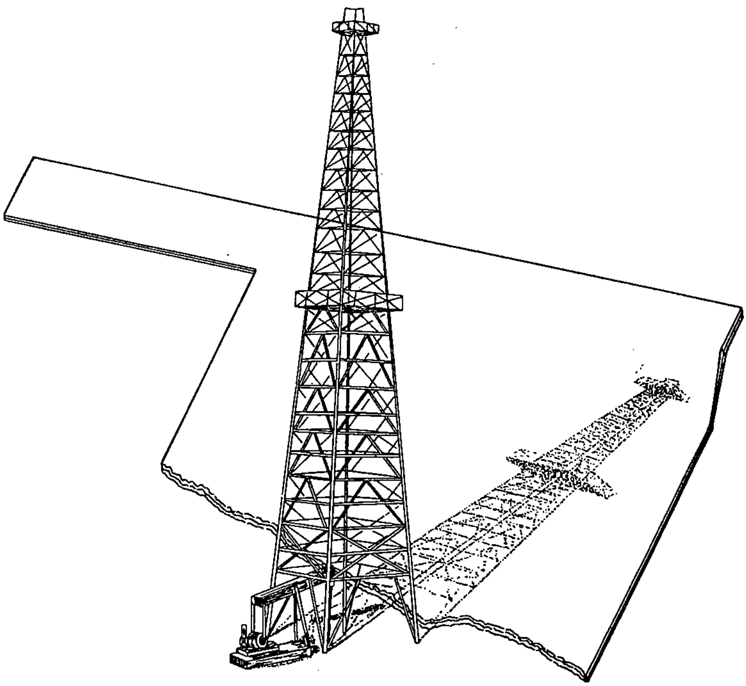
# Oklahoma Geology Notes



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# POTASH AGSTONE IN OKLAHOMA

by

Albert L. Burwell

The name potash agstone was coined by W. D. Keller, a University of Missouri geologist, to designate potash-bearing rock which may be used to replenish potash in depleted soil in much the same manner as limestone, dolomite, and phosphate rock are used to replenish lime, magnesia, and phosphorus. Professor Keller is recognized as a pioneer in this field. His article in the May (1953) issue of Pit & Quarry, entitled "Potash agstones as possible aids to soil improvement", contains much information and suggests avenues for research and development. Just as the addition of limestone is not beneficial to all soils and to all crops neither can potash agstone be expected to be beneficial in all cases. However, a large demand and markets can be predicted if unwarranted claims are not made for the material, - claims that have not been substantiated experimentally. A wide difference of opinion exists regarding the agricultural value of potassium-bearing rocks, much of which is due to lack of exact knowledge of the availability to plants of the contained potash, but the atmosphere is rapidly being cleared as new evidence is being published and new methods of material preparation, other than conventional crushing and grinding, are being tried.

From time to time, attempts have been made to use the potassium-bearing minerals contained in granite rock as replenishing agents in agriculture, since the potassium which occurs in the feldspar and micas is easily released for plant consumption. Foreign scientists recorded the results of their experiments as early as 1912. Numerous reports have been published since that time, some substantiating and some disproving the value of granite rock as a potash source for plant food under local conditions. In 1950, the Connecticut Agricultural Experiment Station at New Haven published Bulletin 536 by T. R. Swanback, entitled "Granite stone meal as a source of potash for tobacco." In the summary, Agronomist Swanback states:

"(1) Granite meal used in the experiments carried a total potash content of at least 7 percent. In addition, the material contained small amounts of calcium and magnesium, and traces of boron, copper, zinc, titanium, nickel, chromium, manganese, lead and possibly vanadium and silver.

(2) It was shown that total potash in stone meal was released by boiling with 5 percent hydrochloric acid solution.

(3) Neubauer tests with stone meal revealed that the root action of rye seedlings released as much potash as would correspond to more than 500 pounds of $K_2O$ per acre in soil.

(4) A solution of about 0.02 normal nitric acid, corresponding to the nitric acid (nitrate) produced in a properly fertilized tobacco field, released 1.14 percent of the potash of the stone meal.

(5) An application of 2 tons of stone meal per acre, combined with the usual amount of nitrogen and phosphoric acid, produced fully as good a yield and quality as the standard 6-3-6 formula."

At about the same time, E. R. Graham of the University of Missouri was working in cooperation with Professor Keller on a number of potassium-bearing rocks. They came to the conclusion that ". . . the uptake of potassium from pulverized potash agstone does occur, varying with the plants, the soil, and the agstone applied."

The fact that several workers on the agricultural use of granite meal have obtained contradictory results and that tests were made under uncertain conditions of fineness and controls, led Charles J. Lyons, Department of Botany at Dartmouth College, to investigate the availability of nutrient potassium in the several minerals of which granite is composed rather than the granite as a whole. He delivered a paper "Nutrient potassium from feldspar and mica" before the American Society of Plant Physiologists at East Lansing, Michigan, on September 7, 1955, in which he described his experiments and the results. In summarizing, he states: "we believe we have shown (1) that the hydrolysis of finely ground microcline and muscovite provides a small amount of potassium ions, used effectively by certain legumes including alfalfa and at least some of the clovers, (2) that naturally weathered biotite supplies potassium in appreciable amounts to a variety of plants in micaceous soils, (3) that Alsike, Ladino and white clover are able to obtain more than hydrolytic potassium from unweathered microcline in true soils, (4) that under certain conditions favorable to their occurrence and growth, one of the sulfur-oxidizing bacteria, probably Thiobacillus thiooxidanes, can release potassium from microcline and muscovite in amounts sufficient to provide this essential element for the growth of tobacco and tomato plants."

## What Is Granite?

For the reader who is not familiar with mineralogical terms, the following explanation is given. According to Dana igneous rocks ". . . are those which have been formed by the cooling and subsequent solidification of a once hot and fluid mass of rock material which is known as a magma." The type of minerals to be found in any igneous rock would depend mainly upon the chemical composition of the molten magma. Obviously there exists a very large number of possible combinations. All magmas are siliceous but where the silica is not present in an amount sufficient to combine with all the basic oxides the resulting rock would not show free quartz. Since granite is composed principally of quartz and feldspar crystals, there must have been present in the magma an excess of silica over that required to combine with the basic oxides to form silicates. C. H. Taylor defines granite in Oklahoma Geological Survey Bulletin 20, "Granites of Oklahoma", as "an igneous rock of deep-seated origin; that is, it was formed at considerable depth below the surface by the solidification of a mass of rock, molten at high temperature. Large bodies of molten rock at considerable depth cool very slowly; smaller bodies, especially at or near the surface, cool much more rapidly. As this molten rock cools, the different minerals crystallize out according to definite laws until the whole is solid." The varieties and color of granite are due to the presence of minerals other than the quartz and feldspar, commonly such minerals as muscovite and biotite. Igneous rocks in Oklahoma other than granite include gabbro, diabase, diorite, and basalt among others. To all intents and purposes it may be stated that all granites are composed of feldspar, quartz and mica with more or less quantities of accessory minerals although the proportions may differ. Feldspars of the orthoclase group and the micas are potassium-bearing minerals and, as such, are important suppliers of that element in soils of which they are a part. It should be mentioned that igneous rock because of its origin in many cases contains the so-called trace elements which are known to be essential to successful plant growth and development. It is known also that in removing crops from the land the soil is gradually depleted of its trace elements and potassium along with other elements needed for plant growth.

Commercial fertilizer manufacturers recognize the fact of soil depletion and offer fertilizer blends calculated to correct the deficiency. In most cases the potassium replacement is in the form of soluble salts such as the chlorides, sulfates, nitrates, and carbonates, and is offered blended with nitrogenous material, phosphate-bearing compounds, and diluents. Chloride of potassium is the most abundant and the lowest-in-cost of the water-soluble potassium salts and is the most used, although the introduction of chloride ion into the soil is in many cases objectionable. The sulfates or nitrates are more desirable, but they both leave the soil in an acid condition after absorption of the potassium by the plants. The reverse is true for the carbonate, which makes the soil alkaline and is unsuited to some crops.

Just as there is a difference of opinion among agronomists regarding the choice of slowly available phosphate in rock phosphate versus readily-available phosphate in "superphosphates", there will undoubtedly be a difference of opinion over the use of more-slowly-available potash agstone in place of quickly available soluble salts of potassium. Probably there is place for both.

## Granite in Oklahoma

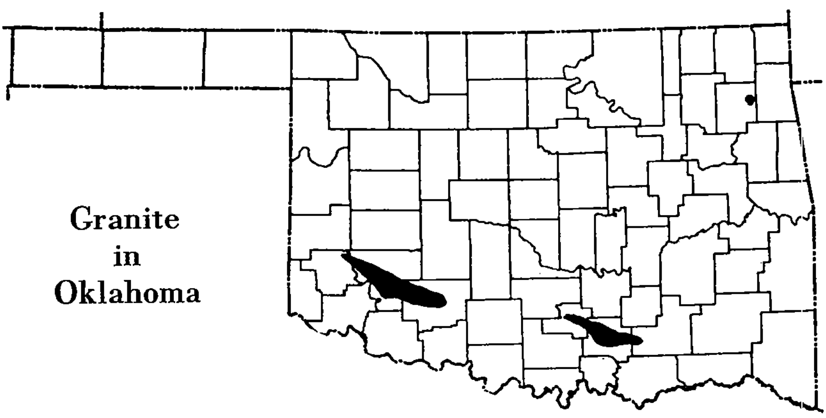
Oklahoma Geological Survey Mineral Report 25 deals with mineral industries in Oklahoma in 1952. The following quotation is from this report:

"The granite industry of Oklahoma is centered in the Wichita Mountain district, in the southwestern part of the State, where production in 1952 was reported from six operators in Comanche, Greer, and Kiowa Counties. During the year a new quarry was opened near Mill Creek, Murray County, in the central part of the Arbuckle Mountains. It is the first granite quarry to be operated in the Arbuckle Mountains in about 35 years.

Production is from pre-Cambrian granites that are predominantly pink and red. The granite is used mostly for monumental stones and partly for exterior trim. Much of the stone is finished in plants in the Wichita Mountain district, but some is exported as rough stock to other states. In 1952 granite production was 5,300 tons with a value of $511,000."

In the quarrying and finishing of granite for use in the building trade and for monumental stone the amount of material actually utilized is an extremely small portion of the raw rock involved in the operation. An enormous amount of material is rejected as defective or unsuitable. The finishing of a panel or monument from a rough block of granite produces a mass of rubble and dust, representing a large percentage of the original block. Further, it should be remembered that rock of a quality suitable for building and monumental purposes is but a small fraction of the total granite which is available if a use can be found for it.

Soils derived from the weathering of granite are recognized as among the most productive agriculturally. The great expanses of badly fractured rock, stone of poor color, or otherwise undesirable granite,—the great piles of discarded blocks in the operating and abandoned quarries, and the accumulation of rubble and dust at the finishing plants arouse only a feeling of contempt, and disparaging remarks such as: "What earthly use can there be for such junk?" However, the question is provocative.




There are several different kinds of granite in the Wichita Mountain area. The differences lie mainly in the physical character of the rock and the minor components which give the distinctive color or appearance. Most of these granites contain approximately 60 percent feldspar, 30 percent quartz, with the balance made up of biotite, hornblende, magnetite, hematite, and other minerals. In the Cold Springs granite, the quartz may be less than 20 percent, whereas the hornblende may be as much as 10 percent, and the feldspar as much as 65 percent. In the Arbuckle

Mountain area, the granites at most places contain 30 to 35 percent quartz and about 55 percent feldspar, with the biotite running from about 3 percent to nearly 10 percent. In the western part of the Arbuckle area, porphyritic rhyolite masses are encountered, but it is expected that chemical analyses would indicate that the rock was derived from a magma similar in composition to that of the other granites of the area.

Chemical analyses of several Oklahoma granites are shown in Table 1, but none is from the Arbuckle Mountain area. However, results of mineralogical examination are given in Oklahoma Geological Survey Bulletin 20, by C. H. Taylor (1915) which indicate the composition and approximate proportions of the constituent oxides, from which it may be assumed that the percentage of the principal oxides is approximately the same in both the Arbuckle and Wichita Mountain granites. Chemical analyses of feldspar fractions separated from a number of granites are given in Table 2.

Material occurring in Oklahoma, other than granites and micas, which may be classed as potential potash agstone includes basalt, diabase, rhyolite, aplite, pumicite (volcanic ash), glauconite, and many shales and clays. These are all classed as silicates. Together with limestones, dolomites, and sandstones they constitute the soil-forming rocks. The potassium content of limestones, dolomites, and sandstones normally is very small and where present can be attributed to the presence of argillaceous impurities or possibly to feldspar grains. Chemical analyses of a few of many volcanic ash deposits indicate a considerable range of potassium content, as shown in Table 3. Table 4 will convey an idea of the potassium content of Oklahoma shales and clays and Table 5 lists several limestones and dolomites for comparison. As a matter of general agricultural information these tables also show the lime, magnesia, phosphorus, and manganese content of the soil-forming rocks.

The availability of the potassium for plant food in the various soil-forming rocks is a matter of considerable importance. Supposing a granite and shale both contain the same percentage of potassium, is it to be expected that the potassium is equally available to plants? Probably not. It is thought that when feldspar weathers it is largely due to acidic constituents in the water with which it comes in contact, such as carbon dioxide. This weathering results in water-soluble potassium compounds. Similar conditions may or may not affect potassium-bearing shales. In some cases, at least, base exchange activity may render the potassium available. In other cases, it may be bacteriological action which supplies the solubilization. What is known about the availability of potassium from the minerals of granite should lead to study on availability of potassium from shales and from volcanic ash which contain potassium in amounts comparable with that of granites.

# TABLE 1

## Oklahoma Granites

<table>
<tr><td>Serial No. *</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Name of Granite</td><td>Cold Springs</td><td>Lugert</td><td>Reformatory</td><td>Spavinaw</td></tr>
<tr><td></td><td>%</td><td>%</td><td>%</td><td>%</td></tr>
<tr><td>$SiO_2$ (silica)</td><td>63.04</td><td>73.61</td><td>74.14</td><td>71.10</td></tr>
<tr><td>$Al_2O_3$ (alumina)</td><td>14.30</td><td>11.97</td><td>12.97</td><td rowspan="3">20.60</td></tr>
<tr><td>$Fe_2O_3$ (ferric oxide)</td><td>1.25</td><td>2.34</td><td>1.07</td></tr>
<tr><td>FeO (ferrous oxide)</td><td>6.12</td><td>1.51</td><td>1.20</td></tr>
<tr><td>CaO (lime)</td><td>4.38</td><td>1.38</td><td>0.48</td><td>0.48</td></tr>
<tr><td>MgO (magnesia)</td><td>1.75</td><td>0.19</td><td>tr.</td><td>tr.</td></tr>
<tr><td>BaO (barium oxide)</td><td>——</td><td>0.04</td><td>——</td><td>——</td></tr>
<tr><td>SrO (strontia)</td><td>——</td><td>0.02</td><td>——</td><td>——</td></tr>
<tr><td>$K_2O$ (potasia)</td><td>3.17</td><td>4.32</td><td>5.30</td><td rowspan="2">3.76</td></tr>
<tr><td>$Na_2O$ (soda)</td><td>3.57</td><td>3.76</td><td>4.61</td></tr>
<tr><td>$H_2O$ (water)</td><td>0.05</td><td>0.32</td><td>0.12</td><td rowspan="2">1.11</td></tr>
<tr><td>L.O.I. (loss on ign.)</td><td>0.72</td><td>0.35</td><td>0.19</td></tr>
<tr><td>$TiO_2$ (titanium dioxide)</td><td>1.43</td><td>0.46</td><td>0.25</td><td>——</td></tr>
<tr><td>MnO (manganese oxide)</td><td>0.09</td><td>0.09</td><td>0.03</td><td>——</td></tr>
<tr><td>$P_2O_5$ (phos. oxide)</td><td>0.28</td><td>0.15</td><td>tr.</td><td>——</td></tr>
<tr><td>Total oxides</td><td>100.19</td><td>100.51</td><td>100.36</td><td>100.09</td></tr>
</table>

Serial No. * Shead, A. C., Chemical Analyses of Oklahoma Mineral Raw Materials, Oklahoma Geological Survey Bulletin 14, 1929.

## TABLE 2
## FELDSPAR FROM OKLAHOMA GRANITES

| Lab. No. | 9983 # | 9995A # | 10023 Al * | 10146 * | 10147 * | 10148 * | 10149 * | 10150 * | 10151 * |
|---|---|---|---|---|---|---|---|---|---|
| Sec. Twn. R. | 3-3S-5E | 6-4S-6E | 26-6N-21W | 20-5N-18W | 19-3N-14W | 22-3N-14W | 32-5N-18W | 22-3N-17W | 32-5N-18W |
| Name | Johnston 10 Acre | Johnston Gravel | Greer Reformatory | Kiowa Campbell Mt. | Comanche Quanah | Comanche Lugert | Kiowa Elk Mt. | Kiowa Radjminski | Kiowa Cold Spring Dike |
| % | | | | | | | | | |
| $SiO_2$ | 64.40 | —— | 66.07 | 67.06 | 66.56 | 67.48 | 65.69 | 68.36 | 65.99 |
| $Al_2O_3$ | 20.98 | —— | 19.22 | 18.81 | 18.82 | 18.54 | 19.58 | 18.43 | 19.72 |
| $Fe_2O_3$ | 0.47 | —— | 0.85 | 0.82 | 0.90 | 0.57 | 0.52 | 0.38 | 0.70 |
| $TiO_2$ | —— | —— | —— | 0.07 | 0.11 | 0.17 | 0.13 | 0.07 | 0.16 |
| CaO | 1.76 | —— | 0.56 | 0.29 | 0.34 | 0.16 | 0.99 | 0.26 | 0.60 |
| MgO | 0.07 | —— | 0.05 | tr. | tr. | tr. | 0.16 | 0.15 | 0.14 |
| BaO | —— | —— | —— | —— | 0.18 | —— | —— | —— | —— |
| $K_2O$ | 7.48 | 8.53 | 7.48 | 6.14 | 6.93 | 7.25 | 8.32 | 7.44 | 7.60 |
| $Na_2O$ | 4.70 | 3.65 | 5.93 | 7.04 | 6.55 | 6.56 | 4.56 | 5.34 | 5.53 |
| $H_2O$ | 0.05 | —— | 0.00 | 0.08 | 0.06 | 0.06 | 0.00 | 0.02 | 0.03 |
| L.O.I. | 0.17 | —— | 0.41 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.12 |
| Total Oxides | 100.08 | —— | 100.16 | 100.31 | 100.45 | 100.79 | 100.05 | 100.52 | 100.59 |

Note: —— not determined * Analyst, T. E. Hamm # Analyst, A. L. Burwell

## TABLE 3
## SOIL-FORMING IGNEOUS MATERIALS

| Material | Location | County | $K_2O$ | $Na_2O$ | CaO | MgO | MnO | $P_2O_5$ |
|---|---|---|---|---|---|---|---|---|
| Volcanic ash# | Sec. 8, T. 5N., R. 28ECM | Beaver | 4.40 | 2.96 | 0.37 | tr. | — | |
| Volcanic ash# | Sec. 15, T. 14N., R. 16W. | Custer | 3.20 | 4.42 | 0.53 | 0.23 | — | |
| Volcanic ash# | Sec. 20, T. 4N., R. 3E. | Garvin | 3.35 | 2.04 | 0.61 | 0.41 | — | |
| Volcanic ash# | Sec. 10, T. 28N., R. 26W. | Harper | 5.67 | 2.91 | 1.08 | nil | — | |
| Volcanic ash# | Sec. 17, T. 19N., R. 12E. | Haskell | 4.07 | 2.55 | 0.68 | 0.38 | — | |
| Volcanic ash# | Sec. 4, T. 9N., R. 12E. | Hughes | 3.98 | 2.41 | 0.78 | 0.35 | — | |
| Volcanic ash# | Sec. 19, T. 10N., R. 10E. | Okfuskee | 4.89 | 2.57 | 0.68 | 0.23 | — | |
| Volcanic tuff* | Sec. 8, T. 5S., R. 26E. | McCurtain | 1.43 | 5.67 | 0.43 | tr. | tr. | 0.04 |
| Basalt* | Sec. 33, T. 6N., R. 1ECM | Cimarron | 0.54 | 2.78 | 9.18 | 5.17 | 0.15 | 0.54 |
| Diorite* | Sec. 10, T. 5S., R. 23E. | McCurtain | 0.53 | 5.84 | 6.02 | 8.29 | 0.10 | 0.13 |

#Burwell, A. L., Cellular Products from Oklahoma Volcanic Ash, Oklahoma Geological Survey Circular 27. (1949)

*Shead, A. C., Chemical Analyses of Oklahoma Mineral Raw Materials, Oklahoma Geological Survey Bulletin 14. (1929)

| Lab. No. | Name | Location | % $K_2O$ | % $Na_2O$ | % CaO | % MgO | % $P_2O_5$ | % $MnO_2$ |
|---|---|---|---|---|---|---|---|---|
| 10034 | clay at Shattuck | Sec. 11, T. 18N., R. 25E. Ellis County | 2.08 | 0.65 | 6.70 | 2.89 | 0.05 | —— |
| 10037 | Hilltop shale | Sec. 11, T. 8N., R. 7E. Seminole County | 2.45 | 0.39 | 0.85 | 2.23 | 0.03 | 0.03 |
| 10086 | Duck Creek shale | Sec. 5, T. 5S., R. 6E. Marshall County | 1.51 | 0.35 | 26.49 | 2.10 | 0.06 | present n.d. |
| 10106 | Cheyenne clay | Sec. 2, T. 14N., R. 24W. Roger Mills County | 2.30 | 0.43 | 9.64 | 3.16 | 0.08 | present n.d. |
| 10111 | Shale (1) over Henryetta coal | Sec. 9, T. 11N., R. 13E. Okmulgee County | 2.60 | 1.01 | 0.90 | 1.91 | —— | 0.13 |
| 10112 | Shale (2) over Henryetta coal | Sec. 9, T. 11N., R. 13E. Okmulgee County | 2.89 | 0.89 | 0.64 | 1.90 | —— | 0.12 |
| 10113 | Shale at Yahola Hill | Sec. 22, T. 15N., R. 16E. Muskogee County | 2.14 | 1.68 | 0.66 | 1.73 | nil | 0.17 |
| 10114 | Shale above Broken Arrow coal | Sec. 2, T. 20N., R. 15E. Rogers County | 2.95 | 1.42 | 0.40 | 1.96 | —— | 0.11 |
| 10115 | Shale above Dawson coal | Sec. 17, T. 22N., R. 14E. Tulsa County | 3.62 | 1.68 | 2.95 | 2.18 | —— | 0.08 |
| 10116 | Nellie Bly (1) shale | Sec. 2, T. 17N., R. 10E. Creek County | 2.32 | 1.46 | 0.86 | 2.18 | nil | 0.06 |
| 10117 | Nellie Bly (2) shale | Sec. 2, T. 17N., R. 10E. Creek County | 2.52 | 1.44 | 2.58 | 2.57 | —— | 0.09 |
| 10164 | Osage Park shale | Sec. 2, T. 26N., R. 10E. Osage County | 3.21 | 1.62 | 3.95 | 3.53 | 0.16 | 0.11 |
| 10165 | Dowd (1) shale | Sec. 12, T. 28N., R. 2W. Kay County | 3.15 | 1.88 | 4.95 | 5.46 | 0.10 | 0.07 |
| 10166 | Dowd (2) shale | Sec. 12, T. 28N., R. 2W. Kay County | 2.53 | 1.38 | 8.85 | 8.10 | 0.08 | 0.17 |
| 10177 | Sericitic shale | Sec. 3, T. 5S., R. 24E. McCurtain County | 1.69 | 1.58 | 8.04 | 11.39 | 0.07 | 0.07 |
| 10193 | Gypsiferous shale | Sec. 13, T. 8N., R. 22W. Beckham County | 2.94 | 1.34 | 6.29 | 5.13 | —— | 0.04 |

## TABLE 5
## SOIL-FORMING ROCKS
## LIMESTONES & DOLOMITES

| Lab. No. | Name | Location | $K_2O$ % | $Na_2O$ % | CaO % | MgO % | $P_2O_5$ % | $MnO_2$ % |
|---|---|---|---|---|---|---|---|---|
| 10081 | Henryhouse marlstone | Sec. 4, T. 2N., R. 6E. Pontotoc County | 0.90 | 0.38 | 37.40 | 6.05 | nil | present |
| 10091 | Baum limestone Chemical grade | Sec. 11, T. 4S., R. 4E. Johnston County | —— | —— | 54.63 | 0.48 | 0.003 | n.d. |
| 10092 | Baum limestone argillaceous | Sec. 11, T. 4S., R. 4E. Johnston County | 0.10 | 0.40 | 27.80 | 18.24 | 0.0001 | —— |
| 10095 | Baum limestone Chemical grade | Sec. 2, T. 4S., R. 4E. Johnston County | —— | —— | 54.63 | 0.38 | 0.000 | —— |
| 9931, 2, 3 comp. | Hale limestone | Sec. 22, T. 13N., R. 20E. Mayes County | —— | —— | 53.57 | 0.76 | 0.09 | 0.04 |
| 9934, 5, 6, 7 comp. | Goodland limestone | Sec. 18, T. 6S., R. 20E. Choctaw County | —— | —— | 55.02 | 0.55 | 0.017 | 0.01 |
| 9897-9900 | Pitkin limestone | Sec. 15, T. 16N., R. 20E. Cherokee County | —— | —— | 50.24 | 1.50 | 0.16 | 0.04 |
| 9821 | Royer dolomite | Sec. 36, T. 2S., R. 3E. Johnston County | 0.059 | 0.036 | 30.16 | 21.64 | 0.003 | sl. tr. |

It seems evident from consideration of chemical analyses of Oklahoma soil-forming rocks that soils derived through the weathering of igneous materials and from many of the shales, originally contain sufficient potassium compounds to take care of plant requirements. Continuous long-time cropping may have reduced the potassium content to the point where the soil is deficient in this element. Other soils have a potassium deficiency because it was not there in the first place. The question naturally arises as to what is the best means of supplying or replenishing the potassium. Currently, the use of soluble potassium salts is the means employed in spite of the high cost of these salts and the introduction into the soil of objectionable byproducts. However, there are areas where crop considerations together with economic considerations have encouraged the use of naturally occurring soil-forming rock. For example, granite dust and granite stone meal are being marketed commercially in Massachusetts, Pennsylvania, North Carolina, and Georgia, and glauconite is being marketed in New Jersey. Where the granite dust and meal are byproducts of existing industry, as is evidently the case in Massachusetts and Georgia and should be the case in Oklahoma to some degree, the cost of preparation of the granite rock will be materially less than where the massive rock must be reduced to small particle size. Keller recommends minus 200 mesh. However, the high cost of crushing and grinding granite rock may be partially reduced by making use of an old-time procedure, namely, by subjecting the rock to a temperature sufficiently high to cause excessive expansion of the mineral ingredients followed by destructive contraction on cooling, especially when the cooling is accelerated by sudden immersion of the hot rock in water. What effect, if any, this treatment might have on the availability of the contained potassium is not known. It is known, however, that heat treatment of some rock minerals renders the potassium more readily available. Experiments conducted in the Oklahoma Geological Survey laboratory have demonstrated that Oklahoma granites heated for short periods in the temperature range between 700 and 1000° C. and quickly water quenched may be pulverized readily by passing through rolls. As a matter of fact, certain coarsely crystalline stone may be crushed between the fingers following this treatment. Further, it has been demonstrated in the Survey laboratory that following this heat treatment when the pulverized material is subjected to action of an electrostatic separator much of the mica and iron-bearing minerals are removed, leaving a mixture of feldspar and quartz. It is, of course, possible to separate these two materials by several means, the usual one being by flotation. Laboratory Sample 9983 in Table 2, represents feldspar separated from granite following the above heat treatment.

It is not within the province of the Oklahoma Geological Survey to conduct experiments in the field of plant science or soils. The information in this paper is presented with the hope that persons and organizations interested in maintaining and rebuilding the soils of Oklahoma will carry on. Not only the farmer and rancher of Oklahoma should benefit but the industrial potential of the State would be materially increased. The preparation of the potash agstone and its use in Oklahoma would appear to warrant further investigation.

## OKLAHOMA FOSSIL JELLYFISH

It is astonishing that jellyfish are preserved as fossils in any kind of sediment. They are about 99 percent water. Well-preserved specimens have been found in black shale of Middle Cambrian age in British Columbia. The Solnhofen lithographic limestone of Bavaria, famous for fossil birds, has yielded fine specimens. Otherwise, fossil jellyfish are indeed rare.

Some unusual specimens from Kansas have recently been described by Ralph H. King (State Geol. Survey Kansas, Bull. 114, part 5). One was collected from the Hickory Creek member of the Plattsburg formation (Missourian) in Johnson County, Kansas; the other from the Calhoun shale (Virgilian) in Greenwood County, Kansas. The specimens are assigned to a new genus, **Duodecimedusa,** characterized by a twelve-lobed disc.

In 1954, Alvin West, Carl C. Branson, and Kenneth Masters collected at a locality north of Stroud, and Masters picked up a fossil of unknown affinities. In the light of the paper by H. J. Harrington and R. C. Moore in which King's description appeared, and on the basis of an identification by R. C. Moore, the specimen is **Duodecimedusa,** identical to or related to **D. wycherleyi** King. The new specimen is as well preserved as one could ask for in a fossil jellyfish. It is a cast about one inch in diameter and 2 inches high. The twelve-lobed bell is succeeded by rows of twelve plate-like elements, the symmetry of which weakens toward the margin. The plates are reminiscent of the pedal lobes and marginal lappets of modern **Pericolpa,** a member of the order Coronata. The slight possibility that the form is in a stage of strobilation is rejected as an interpretation because of the large size of the specimen. The occurrence is in a calcareous unit in the Stonebreaker formation (Virgilian), between the Reading and Elmont limestones. The locality is on a county road on the side of a butte in the NW¼ sec. 32, T. 17 N., R. 6 E.

A similar, but poorer, specimen in the Oklahoma University collection is from Pennsylvanian rocks from Kansas City, Kansas. The four specimens from Kansas and Oklahoma, a cruciform species from Nebraska, and an undescribed species from Egypt are all the known Pennsylvanian jellyfish. In other parts of the Upper Paleozoic, they are even rarer. One specimen is known from the Mississippian of Belgium, two species are reported from the Permian of Germany.

The two Oklahoma University specimens have been lent to R. C. Moore, and it is hoped that he and King will study and describe them.