

minerals under standard ignition conditions. The fortuitous presence of fluxing agents, such as calcium compounds, might well serve to catalyze the reaction and indeed such was found to be the case, but at a considerably higher temperature.

Charges consisting of UO_2 , U_3O_8 , or UO_3 , and TiO_2 , in the molecular proportion $\text{UO}_2/\text{TiO}_2 = 1:2$ and $1:2.5$, heated in argon at 1400°C for 90 minutes, all yielded sintered products which contained a brannerite-like phase as the major component. Little or none of this phase was produced when the charges were heated in air. Examination of polished sections under the microscope showed that the products of charges in which the molecular ratio was $1:2$ were homogeneous, except for trace amounts of unreacted material, whereas the $1:2.5$ products contained considerable proportions of a second phase. Comparison of the x -ray powder patterns showed that the synthetic $1:2$ compound was isostructural with heat-treated brannerite and that the two materials had closely similar unit cells; minor differences in the position and intensity of the diffraction lines were probably due to the presence of Ca, Th, rare earths, Pb and other ions substituting for U in the structure of the mineral. A homogeneous sintered compound, UTi_2O_6 , isostructural with the complex oxide mineral, brannerite, has thus been pyrosynthesized in argon.

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A concurrent investigation of the synthesis of brannerite at the University of Toronto was brought to the author's attention by a paper presented at the Annual Meeting of the Mineralogical Association of Canada, in April 1959, by Mr. J. Patchett. Mr. Patchett reported that a compound of the same composition had been produced by fusion in an arc furnace under an inert atmosphere.

IDENTIFICATION OF PLAGIOCLASE BY FUSION TECHNIQUE¹

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Introduction

Additional investigations have been made by personnel of the Petrography Section into techniques for the economical and efficient fusion of

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plagioclase feldspars for identification purposes. The first techniques investigated included the use of an acetylene-air flame and a high temperature electrical furnace; both of these methods produced plagioclase glasses but were rejected as being unsatisfactory. A piece of apparatus (Gradwell, 1958) which generates a high voltage AC arc was developed in Australia and the relatively low cost of the materials involved recommended it as a possible means for making the glass. The apparatus was constructed by us and found unsatisfactory for powdered specimens and not completely satisfactory for small fragments. It was then suggested that the low voltage AC arc generated by an electrowelder might provide a desirable source of heat. Subsequent tests resulted in the purchase of a portable electrowelder.

The search for a suitable means of fusion has been coupled with tests of the glasses to estimate the probable loss of alkalis and preliminary analyses of glasses formed in the acetylene-air flame and the electrical furnace have been published (Dawson & Maxwell, 1958). This investigation has been extended to glasses made by the electrowelder.

Development

The application of electrical welding apparatus to the fusion of plagioclase feldspars was first tested on a commercial model. Carbon electrodes, which have a soft porous core and copper plating engineered for welding metals, were found unsatisfactory for the purpose. A change was subsequently made to spectrographic carbon electrodes which are solid and do not have copper plating; preliminary tests showed that the arc generated between these electrodes would easily fuse plagioclase. Preliminary tests showed that an end pit was more satisfactory than one cut into the side of the electrode and also that the lowest setting on the electrowelder would be effective. A small commercial electrical welder was therefore purchased and has been in use for 6 months.

Some difficulty was encountered in striking the arc during the first weeks of use, settings of 45 amps. being frequently necessary, but once familiarity was gained with the use of the fine adjustment on the carbon torch, it became possible to strike the arc each time it was required, using the lowest setting (15 amps.) on the electrowelder. The 15 amp. arc is satisfactory for the fusion of labradorite and is believed to be more than adequate for all plagioclases.

The cheapest grade of $12'' \times \frac{1}{4}''$ spectrographic carbon electrodes are regularly used with complete satisfaction (See Figure 1). Pits $\frac{3}{8}'' \times \frac{9}{64}''$, which can be drilled on a standard drill press, are drilled into both ends of the electrodes to receive the plagioclase powder or fragments for arcing. The second electrode of the pair is sharpened to facilitate arcing. Individual electrodes can be re-used several times by sawing off the used

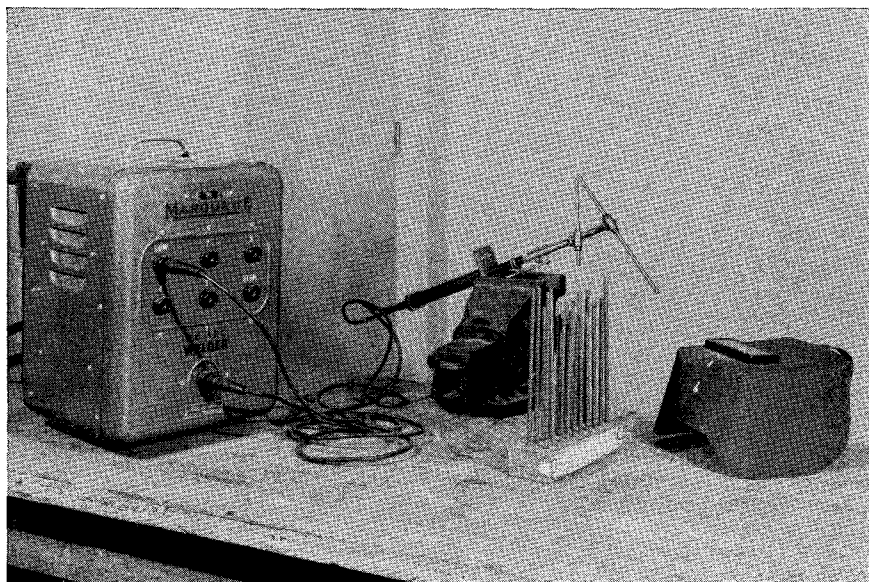


FIG. 1. Portable electric welder with carbon torch, electrodes and eye shield as set up for fusion of plagioclase feldspar.

pit after each fusion; it is possible to re-use pits in many cases but it is better to discard them to avoid contamination of the glasses.

Because of the high temperature of the carbon arc and the appearance of a sodium flame after several seconds of arcing, albite and labradorite of known alkali content were again used to test for the possible loss of alkalis. The sample was fused in the arc only long enough to form beads of glass, rather than for the 15- to 45-minute periods used previously (Dawson & Maxwell, 1958). As will be readily appreciated, there is a considerable difference in temperatures among flames, electrical furnaces, and electrical arcs and fusion in the arc must be done more quickly than by the other techniques. The powdered or fragmented sample cannot be exposed in the arc for more than a few seconds or the glass will be completely vaporized. The resulting beads were submitted to the chemical laboratory where determination of the alkali content was made by flame photometer. The first set of beads were crushed to facilitate dissolution but because of the small sample, amounting to only a few milligrams, it is thought that particles were lost in the process, giving low results for the albite (*See* Table 1). The second set of beads were dissolved without further preliminary treatment, and the two sets of results are given in Table 1. No significant change is evidenced and the method has consequently been used with a greater degree of confidence.

TABLE 1. ALKALI CONTENT OF GLASSES FORMED BY AC ARC FUSION
(Analyst: Serge Courville, Geological Survey)

Plagioclase	Unfused		Fused			
			(Crushed)		(Uncrushed)	
	Na ₂ O ¹	K ₂ O ¹	Na ₂ O	K ₂ O	Na ₂ O	K ₂ O
	%	%	%	%	%	%
Albite	10.47	0.38	9.69	0.34	10.66	0.35
	10.48	0.36	9.79	0.33	10.24	0.30
Labradorite	4.91	0.41	5.67 ²	0.35	4.68	0.38
	4.91	0.41	4.69	0.35	4.73	0.41

¹Na₂O and K₂O values calculated on a H₂O-free basis.

²Value discarded; probable contamination during crushing.

Technique

The technique has been characterized by the use of standard thin sections without coverglasses as a source of plagioclase from medium to coarse-grained rocks. Fragments are cut from the sections to give 3 to 4 beads per section. Powdered material from concentrates can be used with equal ease. The loaded electrodes are placed in the torch and the arc struck by setting the main switch and the fine adjustment. The progress of the fusion is followed with the aid of a colored glass eyeshield and when the plagioclase has formed a spherical bead the arcing is discontinued. The resulting glass beads are freed from the carbon, broken up, and the index of refraction of the glass is determined with suitable immersion oils. The indices of refraction of the beads from a single thin section fall well within 2 mol per cent range. The anorthite content is read directly from a graph prepared (Foster, 1955) from chemically analyzed specimens. The fusion process is the single additional step over those used in immersion work on crystalline feldspars and the isotropism of the glass reduces the number of refractive indices to one, thus simplifying the conventional immersion technique.

Discussion and Conclusions

The electrowelder, although more expensive than the Gradwell apparatus, is less expensive than a suitable electrical furnace; a furnace capable of giving 1550°C costs about 4 times the price of commercial portable welders.

The welder requires a 210 volt circuit for operation and this is generally available in most laboratories. It does not require any expensive controlling circuitry but is operated by a simple toggle switch and once plugged in is ready for operation within seconds.

The electrodes are more convenient to use than the platinum foil, since

the glass forms beads that can either be rolled from the pit or easily loosened with a needle; there is no difficulty through fusion of the glass to the carbon walls under normal condition. The electrodes are also much less expensive than the platinum foil and can be used a dozen or so times without danger of contamination of the glass.

The time required to obtain a glass in the AC arc is only a few seconds, compared with the 7 to 10 minutes required in the flame or electric furnace.

Determinations made to date have been chiefly on plagioclase fragments cut from thin sections of coarse- to medium-grained rocks, but the method works with equal ease for small samples of powdered plagioclase; analyses of the glass have shown that under the conditions used for fusion there is no significant loss of alkalis. The technique is within a single operation of being as simple as the immersion identification of crystalline plagioclase fragments, but reduces the immersion work from the measurement of three indices to only one.

Acknowledgments

The authors wish to acknowledge the assistance of Mr. J. W. VanAlstine in making possible the preliminary fusions on the electrical welder in the National Museum machine shop. Thanks are also due to Survey personnel responsible for the chemical analyses and for the operation of the welding apparatus.

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EUHEDRAL MAGNESITE IN PALAEOZOIC SEDIMENTS FROM SASKATCHEWAN

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Introduction

In 1958, during the drilling of Shell Midale A-6-18-6-10-W2M (about 4 miles S.E. of Weyburn) the wellsite stratigrapher noticed in the drill