NOTES AND NEWS

NOTE ON STRAW-SILICA GLASS FROM CALIFORNIA*

CHARLES MILTON AND NORMAN DAVIDSON

A small fragment, a few grams in weight, of black vesicular glass was received in the Chemical Laboratory of the Geological Survey for identification. Mr. John Davis Buddhue of Pasadena, California, who sent the material, stated (1) that " . . . a small piece of glass (was) found on the surface of a field near Ramona, California. I suspected a haystack fire, but the man who sent it insisted that there had been neither haystacks nor fire near where it was found and that it had not been there when the field was last plowed." It is however certain from the evidence at hand that the specimen does come from a straw or hay-stack fire, although the fire may have occurred many years ago before the knowledge of the present local inhabitants; and the quite stable stony material could well have been buried many years, only recently to be turned up by the plow.

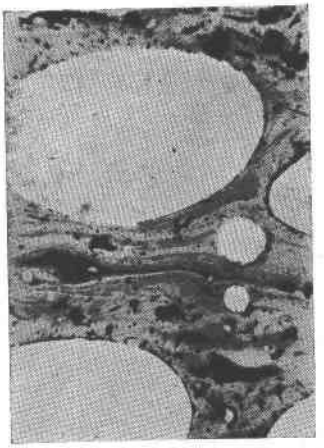

FIG. 1. Microphotograph ×40. Straw-silica glass from Ramona, California. Shows large ovoid and smaller spherical gas vesicles, and linear distribution of carbonaceous particles.

A thin section of the stone shows its highly vesicular character; the vesicles are spherical or slightly ellipsoidal. Usually they are lined with black carbonaceous vegetable debris, which is also strewn throughout the glass. The glass itself is transparent in section, but turbid owing to extremely finely-divided carbonaceous material. It shows flowage, in-

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dicated by the turbid streaks, evidently caused by the expansion of the gas of the vesicles—presumably carbon dioxide or monoxide and steam. A few grains of quartz, evidently from the soil, show indications of peripheral fusion or reaction with the molten glass—otherwise, there are no crystallized substances. The index of refraction of the glass is $1.502 \pm .003$.

Stones of very similar type have been recognized elsewhere. Mr. Buddhue has called our attention to two Australian occurrences. Charles Fenner (2) describes these as "silica glasses, usually fairly scoriaceous but sometimes massive. The material varies from green to black and smoky gray, and at times is found in large lumps up to 20–30 pounds in weight. Inquiry usually shows that the material has been found on or near the site where a straw stalk has been burnt." Two analyses are given of these Australian stones, I and II below; III is an analysis of the Ramona stone; IV is a synthetic glass (3).

	I	II	III	IV
SiO_2	66.04	57.40	70.11	73.59
Al_2O_3	1.55	1.81	.48	.37
Fe_2O_3	.59	.59	.72	
TiO_2			.04	
MnO			.11	
CaO	6.00	8.56	4.94	6.88
MgO	3.80	5.56	3.36	
K_2O	11.98	13.58	8.76	11.56
Na_2O	6.88	8.98	7.97	7.60
H_2O (110° C.)			.02	
P_2O_5			1.03	
Carbonaceous matter	2.69	3.16	1.88	
	99.53	99.64	99.42	100.00
Refractive index			1.502 ± .003	1.508

I No. 19189 Silica glass from O. B. Flat, South Australia. F. L. Dalwood, analyst. Reference 2 (Fenner).

II No. 19190 Silica glass from Compton Downs, South Australia. F. L. Dalwood, analyst. Reference 2 (Fenner).

III Silica glass from Ramona, California, N. Davidson, analyst.

IV Synthetic (commercial) glass. Reference (Winchell).

These analyses may be compared with those of various straw ashes (4).

	1	2	3	4	5
SiO_2	67.50	47.60	49.27	54.04	51.00
Fe_2O_3	.61	.72	1.91	—	1.13
MgO	2.48	2.45	3.10	2.57	2.58
CaO	5.76	6.89	8.20	8.59	7.22
K_2O	13.65	28.91	22.56	25.07	23.26
Na_2O	1.38	2.69	1.74	.10	3.54
P_2O_5	4.81	5.15	6.53	6.07	4.24
SO_3	2.45	3.13	4.25	3.29	3.87
Cl	1.68	2.19	2.18	—	3.18

1 Winter wheat straw ash 5.37% of dry plant..... 18 analyses
2 Summer wheat straw ash 4.45% of dry palant..... 7 analyses
3 Winter rye straw ash 4.46% of dry plant..... 25 analyses
4 Summer rye straw ash 5.45% of dry plant..... 4 analyses
5 Summer barley straw ash 5.35% of dry plant..... 30 analyses

Comparison of the three silica-glass analyses with those of the straw ashes shows a reasonable agreement, with two exceptions. The first is the higher total alkali content in most of the straw ashes. The second is the ten or twelve per cent of $P_2O_5+SO_3+Cl$ reported in the straw ash, but not in the silica stones. The explanation of both discrepancies may be in the stoichometric excess of silica, and the presumably far higher temperature of the formation of the straw-silica glass, as compared to that of the laboratory ashing of the straw. Under natural conditions, the silica would combine with all available basic oxides, displacing the other acidic oxides, which at sufficiently high temperatures will volatilize. At the same time, some soda, as sodium chloride, etc., may be lost.

It may also be noted that the analyses of the straw-silica-stones differ from those of wood ash stones in that these essentially consist of potassium-calcium carbonate. The composition of the straw silica-glass stones, and their peculiar petrographic character, as shown in the illustration, differentiate them from other natural stones, as well as from glasses produced industrially. Fenner points out that the high alkali content of these stones rules out any relation to tektite glasses, as well as to obsidians. In a table listing the composition of some sixteen natural glasses, Morey (5) cites only one whose composition approximates that of the silica stones, this being of "pierres de foudre" i.e., lightning stones "from fusion of grain ash."

In various early editions of Dana's Manual of Mineralogy (6), in particular in the 12th, is an illustration of "Slag from the burning of a stack of wheat straw," showing the characteristic rounded vesicles, but

in addition, "good crystals of melilite and tridymite, besides unidentified microlites." Probably a very large stack, burning on a calcareous soil, would permit such crystallization as Dana describes.

Baker and Gaskin (7) have recently described a natural glass from Macedon, Victoria, which in all essential respects they consider similar to Darwin glass (8). Both glasses, after review of the evidence adduced and theories proposed for their origin, are held to have formed from sedimentary material that has been fused at high temperatures lasting for relatively short periods and (with) rapid cooling. Bush fires, with fierce burning of tree trunks holding silica-rich material which was caught up under special circumstances, are suggested as the source of the heat, and of the material fused. It is to be regretted that no analysis of the Macedon glass is given by Baker and Gaskin; however, the analyses cited of the supposedly very similar Darwin glass differ distinctly from those of straw-silica glass. The fifteen analyses of natural glasses, cited by Baker and Gaskin (9) may be plotted, with the three available of straw-silica glass, using as co-ordinates SiO_2, $Al_2O_3+Fe_2O_3$, and $RO+R_2O$. The three straw silica glasses will fall in a sharply restricted field, characterized by extremely low R_2O_3, and fairly high $RO+R_2O$. Fused desert sand is similarly low in R_2O_3, but also equally low in $RO+R_2O$. Fused charcoal slag is intermediate between straw-silica glass and the fused desert sands.

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(9) *Ibidem*, p. 94.