Coloration Of Alkali Silicates By Carbon Arc And Sunlight

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The coloration of glasses by various agencies such as ultra-violet light, roentgen rays, alpha, beta and gamma radiation has been known for some time.[2] The subject has been studied by many investigators from many different angles. For example, Livingston and Nurnberger[3] have investigated the kinetics of glass-coloring by X-rays and Hoffman[4] has made several studies on discoloration of glasses by radiations. It has been shown that certain ions of manganese, iron, etc., through changes in valency, are responsible for the coloration produced upon exposure to these various agencies.

The observations are usually made on glass samples and it appeared of interest to investigate some pure silicates, with the idea in mind that perhaps their behavior might aid in the eluci-dation of the mechanism of the process of coloration. Accordingly the following samples of silicates were prepared, exposed to the full radiation of a carbon arc for 25 hours and/or to the influence of sunlight for nine months at Bozeman, Montana. Sodium silicate was prepared from sodium carbonate (Baker's C.P. Lot 42031) and silicic acid (Baker's C.P. Lot 2932) in a platinum dish at 1100° C. The product (Na-A, Table I) was quite hard, colorless and clear. When made in a fire-clay crucible the substance (Na-B, Table I) had a straw-yellow color, due to some heavy metal impurity from the walls of the crucible. It was hard, not transparent and cloudy. The third sample of sodium silicate (Na-C, Table I) was obtained from the Philadelphia Quartz Co.[5] It was hard, transparent and of grayish color. All samples were only slightly hygroscopic. Potassium silicate was prepared similarly from potassium carbonate (Baker's C.P. Lot 1528) and the silicic acid mentioned. The product (K-A, Table I) prepared in a platinum crucible was fairly hard, very hygroscopic, transparent and of light blue green color. It had to be exposed in a dessicator under a cello-phane window. When prepared in a fire-clay crucible the silicate (K-B, Table I) had a dark-green color, hygroscopic and not transparent. The sample obtained from the Philadelphia Quartz Co.[5] (K-C, Table I) was quite hard, brown in color, cloudy and only

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[2] S. C. Lind, Chemical Effects of Alpha Particles and Electrons, The Chem. Catalog Co., New York (1928).

[3] R. S. Livingston and Nurnberger, J. Phys. Chem. *39*, 1011 (1935) and *41*, 691 (1937). (Further lit. ref. are here given.)

[4] J. Hoffman, Glas Techn. Ber. 13 (2), 47 (1935).

[5] We wish to thank them for the gift of these samples.

slightly hygroscopic. Lithium silicate (Li, Table I) when prepared from lithium carbonate (Mallinkrodt C.P. Lot 1291811) and the silicic acid mentioned, in fire-clay crucibles became on solidifying a hard, porous dull gray, opaque and brittle mass.

These silicates were exposed for twenty-five hours to a carbon lamp and for nine months to sunlight. Their transparency to visible radiation was determined, before and after exposure, by means of a Keuffel and Esser color analyser. The results of the experiments are given in Table I.

TABLE I. CHANGE IN COLOR AND TRANSPARENCY OF SILICATES AFTER IRRADIATION

Silicate	Irradiation		Color (Visual)		Cloudiness (Visual)		Transparency at 5700A° (%)	
	Hours (Carbon arc)	Months (Sun)	Original	Final	Original	Final	Original	Final
Na-A	----	9	none	none	clear	cloudy	67	45
Na-A	25	----	none	none	clear	cloudy	----	----
Na-A	25	9	none	none	clear	cloudy	67	38
Na-B	25	----	yellow	darker	cloudy	clear	----	----
Na-B	25	9	yellow	darker	cloudy	clear	33	42
Na-C	25	----	gray	gray	clear	cloudy	----	----
Na-C	25	9	gray	gray	clear	cloudy	----	----
K-C	25	----	brown	darker	cloudy	clear	----	----
K-C	25	9	brown	darker	cloudy	clear	16	19
K-A	25	----	blue-green	blue-green	clear	cloudy	----	----
K-B	25	----	dark-green	darker	cloudy	clear	----	----
Li	25	----	dull-gray	dull-gray	cloudy	clear	----	----

It is noted that colorless samples remain colorless during exposure, but they become cloudy and less transparent. On the other hand colored samples become deeper in color and become more transparent on exposure. The transparency measurements in the visible region are shown in Fig. 1 for sodium and potassium silicates. In order to understand the changes taking place in these simple silicates during irradiation, it may be supposed that the primary action of the light is the photo-chemical decomposition of the silicate:

$$M_2SiO_3 + h\nu \underset{\longleftarrow}{\longrightarrow} M_2SiO_2 + \tfrac{1}{2}O_2(g)$$
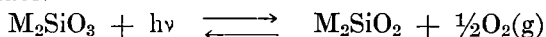
whereby a hypothetical lower valency form of silicon is produced. This action is considered to be reversible and in a pure silicate the steady state may be on the silicate side so that such a substance would appear stable. If however the amount of oxygen becomes
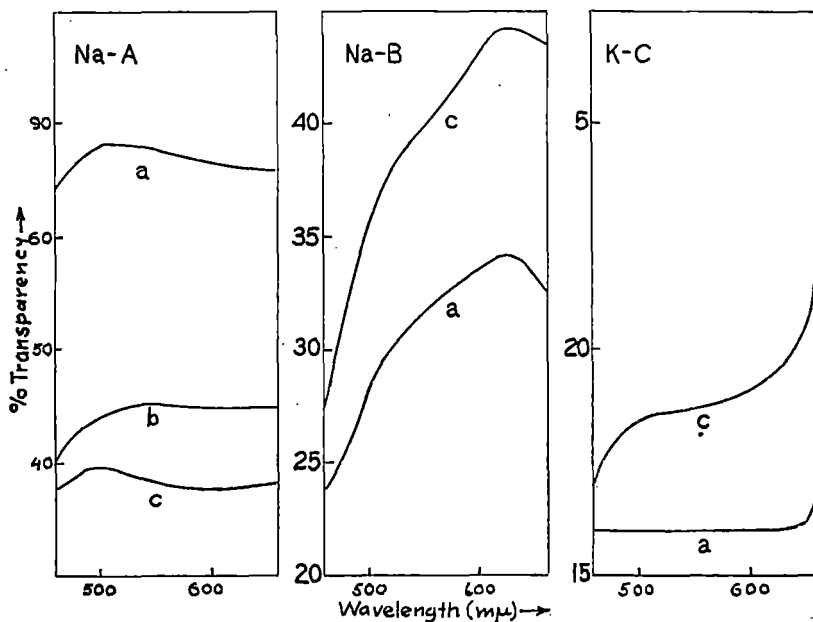
Figure I. Transparency of alkali silicates before and after irradiation. a = no irradiation; b = 9 months of sunlight; c = 25 hours of carbon arc and 9 months of sunlight.

appreciable on irradiation, the transparency of the sample should decrease, it should appear cloudy, but its color should not necessarily change (Case 1, 2 and 4, Table II). If however the silicate is originally colored by some impurity such as iron oxide, the latter may serve as an agent for the removal of oxygen:

$$M_2SiO_3 + h\nu \longrightarrow Me_2SiO_2 + \frac{1}{2}O_2$$
$$2FeO + \frac{1}{2}O_2 \longrightarrow Fe_2O_3$$
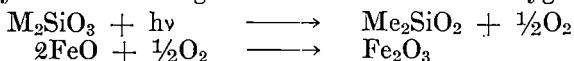
The originally colored samples should then become more highly colored but not less transparent (Case 3 and 5, Table II). The impurity may serve further as a sensitizing agent for the photochemical reaction. Divalent silicon has been described before[6] and its use in the above appears as plausible as any other mechanism so far proposed. Most likely, the picture envisaged here is not the only mode of reaction possible. It is hoped that the findings reported herewith may perhaps contribute towards the final solution of a baffling problem.

Summary: Pure sodium and potassium silicates have been irradiated with a carbon arc and in sunlight. Originally colorless samples do not show coloration upon exposure but they become less

[6] M. K. Hoffmann, Lexikon d. anorg. Verbindungen I: 1, J. Barth, Leipzig (1917).

transparent. Initially colored samples become more transparent and they deepen in shade. It is supposed that liberation of oxygen causes decrease in transparency. This clouding up of the material is avoided when an originally colored sample is treated because the color-giving impurity can remove oxygen, producing an increase in shade and a slight increase rather than a decrease in transparency.

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APPLICATION OF REFLECTION SEISMIC PROSPECTING TO OUTLINING OF OIL-BEARING GEOLOGICAL STRUCTURES

ABSTRACT

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Seismic prospecting as it exists today had its beginning between 1920 and 1925. While it has many successful applications in the field of civil engineering such as in the determination of underground conditions in dam construction, in highway work, and in similar problems, nevertheless, because of the large financial resources controlled by the petroleum industry, its most extensive application has been in that field. While other applications are of great interest this discussion is limited to reflection surveying as applied to the discovery of oil.

To understand how the reflection method works we must know something about the geology involved. Before oil can accumulate it is necessary that there exist certain geological conditions favorable to this accumulation. Since oil is lighter than water, if there is a portion of a porous horizon which is higher in elevation than the neighboring points of that horizon, oil may accumulate in this region. Such a formation or structure is called an anticline. Similarly if a porous horizon is sealed off by a fault or by an unconformity there may likewise be a deposit of oil. In seismic prospecting we do not attempt to find oil directly but rather indirectly by outlining the structure and thereby determining whether or not the geological conditions are such that oil might have accumulated.

The method employed is simply to measure very accurately the time required for a sound wave produced by an explosion to travel from a given point in the ground to another point, the sound waves in general taking a variety of paths in going from the first point to the second. The physical fact which allows us to determine the underground structure is that the velocity of the sound depends upon the formation through which the sound is travelling. The velocity of sound in air is about 1,100 feet per second. The velocity of sound in sandstone varies with the degree