XVI.—*On so-called Green Garnets, from the Urals.*

By A. H. Church.

SOME extremely beautiful but rather soft gems of various green hues have been extensively sold during the last year or two. They are found in the gold washings of the river Bobrowska, near Poldnewaja, district of Syssersk, in the Urals, and occur in the form of nodular masses, varying in size from a pea to a chestnut. These closely resemble the jelletite from Monte Rosa. All the specimens which I have examined present a roughly radiate structure, are irregularly fissured and veined, and are coated with a talcose mineral, glistening and nearly white. The exposed uninjured surfaces of the nodules are minutely and unevenly striated. The mineral shows no cleavages, but the broken surfaces have a resinous or semi-adamantine lustre, and show a small conchoidal fracture. The transparency of the mineral is complete, and its refractive and dispersive power very high, so that the cut stones exhibit a remarkable amount of "fire," especially by artificial light. The colour varies much, ranging from a somewhat yellowish emerald-green through pistachio, asparagus and olive-green to a liver-brown. The hardness of the mineral is about 6. It fuses to a black bead before the blowpipe.

The specific gravity of this mineral may be taken as 3·85. This figure was deduced from three determinations, made with every care by means of one of Oertling's most delicate assay balances. The liquid employed was rather dilute alcohol, three cut and nearly flawless specimens of the mineral in question being used for the experiments, of which the details are here given :—

No. and Colour of Specimen.	Weight in Air.	Weight in Alcohol.	Sp. Gr. of Alcohol.	Temp.	Sp. Gr. of Mineral.
i. green-yellow	1·0446	·8148	·8478	16°	3·854
ii. pistachio-green	·5044	·3929	·8506	13°	3·848
iii. emerald-green	·2188	·1704	·8506	13°	3·8494

Analyses of the pistachio-green variety of this mineral gave the following results :—

Analysis I.—Fusion with potassium and sodium carbonates.

·6895 gram gave ·252 gram $Si\,O_2$
·412 ,, $Ca\,CO_3$
·226 ,, $Fe_2\,O_3$
·007 ,, $Al_2\,O_3$
·016 ,, $Mg_2\,P_2\,O_7$

Analysis II.—Fusion with above mixture and nitre.

·5005 gram gave ·308 gram $Ca\ CO_3$
·1645 ,, $Fe_2\ O_3$
·005 ,, $Al_2\ O_3$
·0055 ,, $Mg_2\ P_2\ O_7$

Analysis III.—Fusion with potassium and sodium carbonates :—

·5065 gram gave ·193 gram $Si\ O_2$
·1695 ,, $Fe_2\ O_3$ and $Al_2\ O_3$
·303 ,, $Ca\ CO_3$
·0055 ,, $Mg_2\ P_2\ O_7$

The following percentages represent the above results :—

	Analysis I.	Analysis II.	Analysis III.
$Si\ O_2$	36·55		38·10
$Fe_2\ O_3$	32·78	32·86	33·46
$Al_2\ O_3$	1·01	1·00	
Ca O	33·46	34·46	33·50
Mg O	·83	·40	·39

The mean results (omitting the $Si\ O_2$ of analysis III) will stand thus—

Silica	36·55
Ferric Oxide	32·82
Alumina	1·01
Lime	33·96
Magnesia	·54
	104·88

But further experiments showed that part of the iron in the mineral exists in the ferrous state, a conclusion to which the green colour of the substance also points. In order to dispose of the 4·88 parts in excess in the above analysis, we must assume that the ferrous and ferric oxides in the mineral exist in these percentage proportions.

Fe O	19·52 per cent.
$Fe_2\ O_3$	8·42 ,,

The whole analysis will then be represented by these percentages :—

Silica	36·55
Ferrous Oxide	19·52
Ferric Oxide	8·42
Alumina	1·01
Lime	33·96
Magnesia	·54
	100·00

Now the formula (3 Ca O, $Fe_2 O_3$, 3 Si O_2) for lime-iron garnet demands these numbers :—

Silica	35·43
Ferric Oxide	31·50
Lime	33·07

If, as it seems we must conclude, two thirds of the iron in this Ural mineral exist in the ferrous state, its claim to be regarded as a true garnet can hardly be maintained. Its crystalline character is not only imperfect but can scarcely be recognized. Its hardness, about 5, is low for a garnet, though its refractive and dispersive power is high. Though not unlike jelletite in outward aspect, it does not show the distinctive crystalline structure of that variety of garnet.

The formula which most nearly corresponds to the analytical results detailed above, is 9 CaO, 4 FeO, $Fe_2 O_3$, 9 Si O_2. The following comparison of theoretical and experimental percentages shows this—

	Theory.	Experiment.
Silica	36·19	36·55
Ferrous Oxide	19·30	19·52
Ferric Oxide	10·72	8·42
Lime	33·78	33·96

I do not feel entirely satisfied with the formula I have just suggested for this green mineral. It cannot, however, be considered in any sense a true garnet, for even allowing some excess of ferrous oxide to have been introduced into my calculation, there still remains a serious deficiency in the sesquioxide constituent. Attempts to determine directly the ferrous and ferric oxides present have not as yet been successful, although the simple experiment of moistening the finely-ground mineral with dilute sulphuric acid, and adding a little potassium permanganate solution, proves the presence of the reducing ferrous oxide. Further study of the mineral is required, and it is possible that some such study may have been published on the continent, and may have escaped my notice. I have now set out my own results obtained two years ago, imperfect as they are, for the press of other work still precludes me from completing the inquiry.