On Nemalite from Afghánistán.

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In 1887, when I was in charge of the Indian Geological Survey laboratory, a specimen of a mineral recently discovered in Afghánistán was sent to Calcutta by the British Agent at Kábul, with a request for information as to its nature and value. It proved to be nemalite, and a quantitative analysis of it, which was subsequently made by Mr. T. Blyth, is published in the fourth part of *A Manual of the Geology of India*, p. 161. As it seemed possible that the mineral might be capable of some useful application if plentiful, and it was in any case of mineralogical interest, a request was made to the Agent for further information about it, including the locality where it was found, and for additional specimens. The information asked for did not appear to be procurable, but a box full of the mineral, containing, as far as I remember, more than half a hundredweight of the substance, was sent to the Geological Museum. When retiring from India some years ago, amongst a few specimens of Indian minerals which, with the permission of the then Director of the Survey, Dr. King, I brought to England, in the hope of being able to examine them at some future time, was a picked sample of the nemalite in question. It is, however, only recently that circumstances have allowed of my making a commencement of such work, by an examination of the mineral I have alluded to.

The specimens sent were all very similar to each other in outward appearance, but differed more or less in the amount of alteration they had undergone, which could be roughly judged by eye through variations in colour and translucency. The sample I selected was one of those which appeared to have undergone the least change.

It consists of a mass of straight, very fine, highly flexible and elastic, easily separable fibres eight inches long, which seem clearly to have formed part of a vein. Some particles of serpentine, adherent to one end of the specimen, indicate that the rock in which brucite has generally

been found elsewhere is the probable matrix in Afghánistán also. The ends of the specimen show that the fibres were not perpendicular to the walls of the vein, as is more usually the case with fibrous minerals, but made an angle with the walls of about 20 (or 160) degrees. Whether this was due to a local twist in the direction of the walls at the spot from which the specimen was taken, or is common to the whole vein, I do not know.[1] Both ends of the specimen show very obvious signs of chemical alteration, but the central part, for about five inches, is, to all outward appearance, both to the naked eye and under the microscope, perfectly fresh; and that it has not undergone any considerable change is shown by the absence of both carbonic acid and ferric oxide. The sample used for examination was of course taken from this portion.

Viewed transversely to the fibres the colour by reflected light is sea-green, with a silky lustre; by transmitted light, pale to dark sea-green, according to the thickness of the specimen. Viewed by transmitted light parallel to the direction of the fibres, the colour is very similar. In a specimen an inch long, the colour is sufficiently intensified to approach a pale emerald-green. The colour of the mineral is doubtless due, mainly at least, to the unusually large amount of ferrous oxide it contains. There is no perceptible dichroism.

A section perpendicular to the direction of the fibres[2] shows no dark cross or rings in convergent polarised light. In parallel light, with crossed nicols, the field is rather brightly illuminated, and rotation of the nicols together does not alter the illumination. A cylinder of the fibres, again, lying parallel to the stage of the microscope, exhibits double refraction, and no alteration in the phenomenon is observable during a rotation of the cylinder on its own axis. The optical elasticity is greater in the direction of the fibres than transverse to them. The above observations are in consonance with the statement of Lévy and Lacroix, that in nemalite "les fibres sont allongées suivant un des côtés de l'hexagone et négatives,"[3] and, with the optically positive character of brucite, nemalite included. But they apparently indicate that the vertical crystallographic axes, *c*, in the different fibres (which are so minute that in a cross section they are individually quite invisible

[1] Dr. Hidden, who was present when this note was read, remarked that the Nemalite of Hoboken, N.J., shows a similar obliquity between the direction of the fibres and that of the walls of the vein.

[2] I am indebted to Professor J. W. Judd, C.B., for kindly having the section cut for me, and also for several references bearing on the subject of brucite.

[3] *Les Minéraux des Roches*, 1888, p. 162.

under the microscope[1]) lie, not in parallelism with each other, but in varying directions in the plane perpendicular to the cross section of the fibres.

The value obtained for the specific gravity, at 60° F., is 2·454; a high result, which must be ascribed to the large amount of iron present.

The mineral (free from hygroscopic moisture) gave on analysis:—

		Oxygen ratio.[2]	
Magnesia	62·00	24·58	26·33 (or 1·003)
Ferrous Oxide ...	7·87	1·75	
Manganous Oxide...	trace		
Water	29·55		26·24 (or 1)
Silica	·38		
	99·80		

A faint trace of lime was detected spectroscopically.

The only point in which the above figures differ noticeably from Mr. Blyth's is in the smaller amount of iron; but the sample used in his analysis was from a different specimen, obtained at a different time, and possibly from a different part of the vein; and more or less variance in the relative proportions of the isomorphous oxides is what might be expected.

The silica is left undissolved by hydrochloric acid, in the form of translucent tangled fibres, which dissolve in a hot solution of sodium carbonate. They are indistinguishable in appearance from the siliceous fibres which remain when chrysotile is decomposed by the same reagent. As nemalite and chrysotile are usually found under similar conditions—in the form of veins traversing serpentine—it seems not unnatural that the two allied magnesian fibrous minerals should co-exist intimately mixed in the same vein, and it appears not improbable that such is the case in the substance under discussion.

If, then, the silica be regarded as a constituent of chrysotile, and to the latter be assigned the theoretical composition of the mineral, with the magnesia and iron in the same proportions relatively to each other as in the nemalite, the above analysis will stand as follows:—

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[1] With linear magnification of 180.

[2] Mg = 24·36, Fe = 56·00, H = 1·0076

	Chrysotile.	Nemalite.	Calculated to 100.		Oxygen Ratio.
Magnesia ...	·35	61·65	62·32	24·71	26·47 (or 1·001)
Ferrous oxide ...	·04	7·83	7·92	1·76	
Manganous oxide	—	tr.	tr.		
Water	·11	29·44	29·76		26·43 (or 1)
Silica	·38				
	·88	98·92	100·00		
	99·80				

Granting the existence of the chrysotile, whether it should be regarded as formed synchronously with the nemalite, or as present owing to one mineral having been altered into the other, I do not know. As previously remarked, the substance analysed showed no indication of change unless the presence of silica be regarded as such. On the other hand, a portion of the substance near the end of the specimen, where it was obviously changed, contained 2·26 per cent. of silica fibres, = 5·28 per cent. of chrysotile, or six times as much as the portion fully analysed. But this excess of silica was accompanied by the presence of carbonic acid and ferric oxide, which might, therefore, perhaps be expected to accompany the smaller amount of silica (·38 per cent.) also, if the latter were due to alteration of the nemalite; and the larger percentage of silica may be caused merely by original unequal distribution of chrysotile through the specimen.

Near the ends of the specimen the original green colour is changed to a light hair-brown, the mineral still retaining its translucency, the alteration being due to a very partial peroxidation of the iron. Beyond that, again, the fibres are white, with a pale reddish tinge, and comparatively opaque. This portion (besides the silica mentioned above) contains a considerable quantity of carbonic acid, owing to the nemalite having been more or less fully converted into hydromagnesite; and the ferrous is largely, or entirely, changed to ferric oxide. There is also a certain amount of non-fibrous and scaly, or in part stellate-lamellar, hydromagnesite on the ends of the specimen, which was formed, apparently, by deposition on the nemalite, not by alteration *in situ*. This hydromagnesite encloses some magnetite, which may perhaps be taken as representing part of the ferrous oxide of the nemalite (from some other portion of the vein), from which the deposited hydromagnesite was probably formed.