CHLORITOID AT KALGOORLIE

Rex T. Prider, *Department of Geology, University of Western Australia, Nedlands, Western Australia.*

Introduction

Gustafson (1) has recently noted the occurrence of chloritoid at Porcupine and Kalgoorlie. He considers the chloritoid at these two localities to be of hydrothermal origin and therefore that it is necessary to revise the general opinion that chloritoid is a stress mineral. My studies of the chloritoid-bearing rocks of Kalgoorlie indicate, however, that the development of chloritoid, although due to hydrothermal alteration of the greenstones, is only an indirect product of this alteration, viz. that hydrothermal changes in these basic igneous rocks has produced a suitable environment in which chloritoid has subsequently developed under conditions of stress metamorphism. Moreover since Gustafson does not give any details regarding the Kalgoorlie occurrence, some of my observations of the areal extent of the chloritoid-bearing greenstones may be of interest.

Occurrence

Simpson and Gibson (3, pp. 142–143) first noted the occurrence of chloritoid at Kalgoorlie and Simpson (2, pp. 27–30) subsequently published a detailed description with chemical analyses both of the chloritoid and the enclosing rock. Stillwell (4) has contributed nothing further regarding the occurrence of the chloritoid but indicates the locality where it had been found on his geological map. Up to this time (1929) the only known locality was a shaft at the north-east corner of the Lake View townsite (Fig. 1). In 1932–33 five boreholes were drilled in the area to the south of the Trafalgar railway station (Fig. 1) by the South Kalgurli Consolidated, Ltd., by whom I was, at that time, employed. These boreholes disclosed a wide belt of quartz doleriate greenstone containing abundant chloritoid. The chloritoid-bearing zone is at least 800 feet wide and extends at least 50 chains along the strike. Summarized logs of these boreholes, the locations of which are shown in Fig. 1, are as follows:

Bore No. 1. Depression 45°; depth 600 feet.

The only rock type encountered was slightly bleached quartz dolerite greenstone* containing chloritoid throughout. The presence of chloritoid in these rocks is not very evident in the hand specimen but the microscope reveals its presence throughout the whole borehole.

* Nomenclature of the greenstones is that used by F. L. Stillwell: *Geol. Surv. West. Aust., Bull.* **94.**

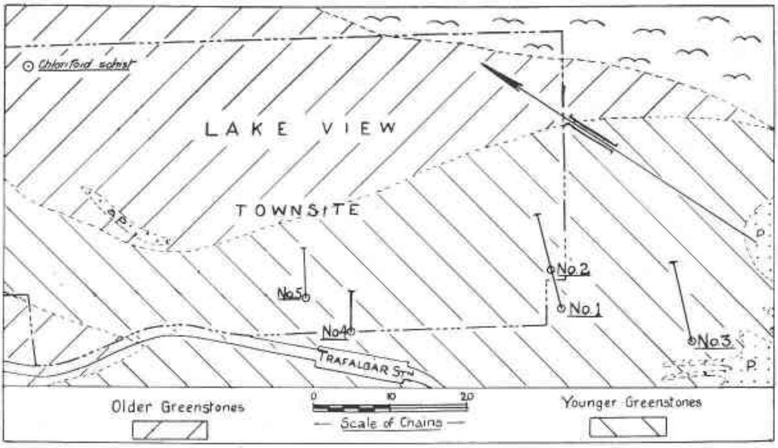


FIG. 1. Geological map of the vicinity of Lake View townsite, Kalgoorlie (taken from F. L. Stillwell's map published with *Geol. Surv. West. Aust., Bull.* **94**) showing location of boreholes. Dotted areas are the porphyrites (P = porphyrite; aP = albite porphyry) and flying birds sign is superficial alluvium.

Bore No. 2. Depression 45°; depth 500 feet.

The only rock type represented is a highly bleached (ankeritized) and sheared quartz dolerite greenstone with abundant chloritoid giving the rock a spotted appearance. Between depths of 374 and 448 feet, and also 488 and 500 feet, the rock was a fine-grained silky-lustred schist (? calc schist of the Older Greenstone Series) with spotted appearance due to the development of abundant chloritoid porphyroblasts averaging 1 mm. diameter.

Bore No. 3.† Depression 45°; depth 905 feet.

The three specimens (from 190′, 746′ and 905′) available from this borehole are all somewhat sheared and ankeritized quartz dolerite greenstones containing chloritoid. In the first two specimens the chloritoid is rather sparsely developed while in that from 905′ it is abundant.

Bore No. 4. Depression 45°.

The three specimens (from 181′, 363′ and 400′) available from this bore are all highly ankeritized quartz dolerite greenstones. The first two contain no chloritoid and that from 400′ very rare chloritoid.

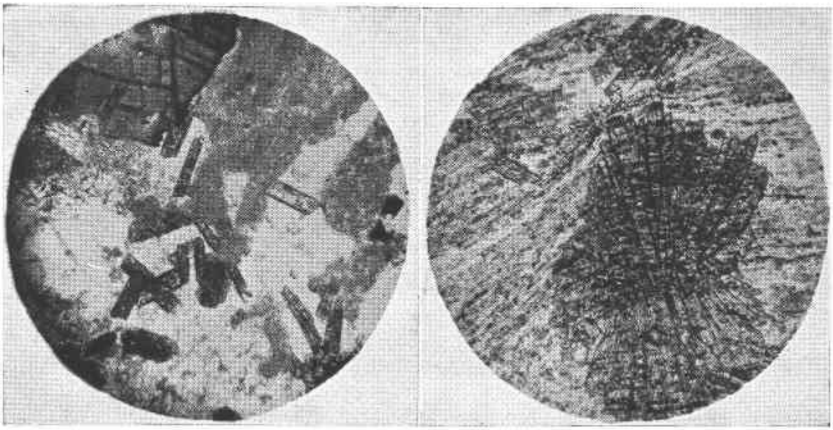
Bore No. 5. Depression 45°; depth 620 feet.

To a depth of 210 feet the rock was a bleached and sheared quartz dolerite greenstone without chloritoid; from 210 to 290 feet it was quartz dolerite greenstone with rare chloritoid; from 290 to 440 feet it was a silky lustred schist (? calc schist of Older Greenstone Series) with abundant chloritoid; from 440 to 570 feet it was albite porphyry (?) with occasional chloritoid and fairly abundant microscopic needles of tourmaline; from 570 to 620 feet a schist similar to that between 290 and 440 feet was encountered.

These bore-logs indicate therefore that chloritoid is developed in the various metasomatized rocks of the Kalgoorlie Series—in the Older Greenstones (calc schists which are ankeritized basic lavas), in the in-

† Boreholes 3, 4, and 5 were drilled subsequently to my departure from Kalgoorlie. I am indebted to Mr. H. B. Newman, Underground Manager of South Kalgurli Cons. Ltd., for specimens from these bores.

trusive Younger Greenstones (quartz dolerite greenstones), and in the still younger albite porphyries—over a band at least 800 feet wide (the eastern margin of this chloritoid-bearing band was not encountered in any borehole). Simpson (2, p. 28) considers that all the chloritoid-bearing rocks which he examined from the shaft at the north-east corner of the Lake View townsite were variants of the intrusive quartz dolerite (Younger Greenstones). By courtesy of the Government Geologist of



2 3

FIG. 2. Photomicrograph of bleached quartz dolerite greenstone showing chloritoid (high relief) confined to sericitic areas (colorless) after feldspar. The greyish cloudy material is an aggregate of chlorite and ankerite after original ferromagnesian minerals. A large plate of leucoxenized ilmenite is visible. Photo taken in transmitted light with some reflected light to show up the skeletal ilmenite. ×30. (*Photo. by H. J. Smith*).

FIG. 3. Photomicrograph of sheaf-like bundles of chloritoid prisms in highly sheared quartz dolerite greenstone, showing schistosity passing through the chloritoid and slight distortion of the schistosity by growing chloritoid. ×40. (*Photo by H. J. Smith*).

Western Australia (Mr. H. A. Ellis) and the Government Mineralogist (Mr. H. Bowley) I have been able to re-examine Simpson's specimens and find that they are all calc schists of the Older Greenstone Series. The occurrences disclosed by the five bores described above are, therefore, the first record of chloritoid in the intrusive quartz dolerite group of rocks. That these rocks undoubtedly belong to the quartz dolerite greenstones will be evident from Fig. 2 in which, in spite of the extensive metasomatism, the original ophitic texture can be readily discerned, as can the large skeletal plates of leucoxenized ilmenite which are such a characteristic feature of the quartz dolerite greenstones.

The manner in which the chloritoid occurs in these quartz dolerite greenstones is shown in Figs. 2 and 3. Figure 2 shows the occurrence of isolated porphyroblasts of chloritoid in an unsheared but highly metasomatized quartz dolerite greenstone. A significant feature of this rock is that the chloritoid is confined to the sericitic aggregates which are pseudomorphous after the original feldspar and do not occur in the darker-colored chlorite-ankerite aggregates which represent the original ferromagnesian minerals. The sericitic environment in which the chloritoid is here developed does not differ much from a sericitic phyllite, the normal rock in which chloritoid is commonly developed (5). Figure 3 illustrates the manner in which the chloritoid is developed in the more highly schistose rocks. Here it occurs in sheaf-like bundles scattered uniformly throughout the rock which is a carbonate sericite schist. The schistosity passes through the later developed chloritoid porphyroblasts and is somewhat distorted by the growing chloritoid prisms—the late development of the chloritoid is here very evident.

In both of the rocks illustrated the chloritoid has developed in a sericitic environment similar in character to a sericite phyllite. The analyses of the chloritoid-bearing calc schists given by Simpson (2, p. 28) show that these rocks are rich in alumina and ferrous oxide and comparatively poor in lime and magnesia, most of which, in any case, is in the form of ankerite. This alumina-rich and lime-poor environment is the one in which chloritoid normally develops (5, p. 317).

Conclusions

Chloritoid is developed at Kalgoorlie in both the Older and Younger Greenstone Series over a considerable area. Its development is the result of metasomatism of basic igneous rocks yielding a favorable alumina-rich and lime-poor environment in which it has been developed by low-grade dynamothermal metamorphism subsequent to the main shearing movements and hydrothermal alteration to which the rocks of the Golden Mile have been subjected. Its development is due to stress and the part that hydrothermal changes have played is not in the introduction of the chloritoid but rather in producing a suitable medium in which it could develop.

References

1. Gustafson, J. K. (1946), Two occurrences of chloritoid as a hydrothermal mineral in igneous rocks: *Am. Mineral.*, **31**, 313–316.
2. Simpson, E. S. (1930), Contributions to the Mineralogy of Western Australia, Series V: *Jour. Roy. Soc. West. Aust.*, **16**, 25–40.
3. Simpson, E. S., and Gibson, C. G. (1912), The geology and ore deposits of Kalgoorlie, Part I: *Geol. Surv. West. Aust., Bull.* **42.**
4. Stillwell, F. L. (1929), Geology and ore deposits of the Boulder Belt, Kalgoorlie: *Geol. Surv. West. Aust., Bull.* **94.**
5. Tilley, C. E. (1925), Petrographical notes on some chloritoid rocks: *Geol. Mag.*, **62,** 309–319.