DISCOVERY OF THE GEORGE CREEK, COLORADO KIMBERLITE DIKES

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Extensive heavy mineral sampling, detailed geophysical surveys and exploratory trenching resulted in discovery of the George Creek kimberlite dikes. The George Creek kimberlites are situated within the northeastern Colorado Front Range, approximately 22 kilometers northwest of the reported Sloan kimberlites (Fig. 1).

The regional geology consists predominantly of metasedimentary and metavolcanic rocks of Proterozoic age that have been severely deformed and extensively intruded by late Precambrian plutonic rocks. The metamorphic host rocks are mainly schist and gneiss units formed from a sedimentary and volcanic suite deposited between 1.8 and 2.5 b.y. ago (Peterson and Hedge, 1968). The thick sequence was deformed into large isoclinal folds and then weakly metamorphosed prior to 1.75 b.y. ago. At about 1.75 b.y., these rocks were intruded by the Rawah Granite Complex, subjected to two episodes of folding and strongly metamorphosed producing amphibolite facies rocks having east-west and northeast trending foliations. At about 1.4 b.y. ago, Silver Plume granites and related rocks were emplaced with associated translational deformation.

Regional stream sediment sampling revealed a typical kimberlitic mineral suite comprising subangular to angular peridotitic and eclogitic garnets and trace quantities of chrome diopsides, altered magnesian ilmenites and spinels. Peridotitic garnets from the George Creek exploration samples are characterized by lherzolitic (G9) and high chrome - low calcium (G10) harzburgitic compositions (Dawson and Stephens, 1976).

Detailed soil sampling along a north-south grid system defined an erratic northeastern trend suggesting the presence of nearly linear kimberlite intrusives. A comprehensive geophysical programme was initiated to delineate probable kimberlitic sources. The VLF (very low frequency) method defined several northeast and east-west trending linear conductive zones. The in-phase profiles are symmetrical indicating that the conductive bodies are steeply dipping. Exploration trenching confirmed the presence of at least three separate kimberlite intrusions within northeast trending conductivity regions delineated by the VLF method. Magnetic surveys did not discriminate kimberlite dikes in the George Creek area because large scale amplitude variations of the magnetic field likely overshadowed local magnetic effects caused by the relatively narrow, highly weathered linear kimberlite features.

The kimberlite intrusions (Fig. 1), comprise northeast trending en echelon dikes ranging in length from several hundred meters to 1 kilometer and in width from several centimeters to about 4 meters. Kimberlite creep zones are present but irregular along much of the K-1 and K-2 dikes. Creep zones are reddish-brown in colour, range in thickness from several centimeters to 1 meter and extend downslope several tens of meters from the kimberlites. The kimberlites are essentially massive, distinctly macrocrystic and contain minor amounts of megacrysts, eclogites and serpentinized peridotitic nodules. The dikes have apparent dips of 70°NW to nearly vertical, show little or no surface expression and are covered by 1 to 5 meters of colluvium. Contacts of the kimberlite dikes with the enclosing amphibolite grade gneisses are typically sharp and narrow. Minor serpentine and carbonate veinlets (1 to 3 cm wide) extend outward up to 1 meter into the gneiss in places along K-1 but are not characteristic of the K-2 and K-3 kimberlites (Fig. 1).

The George Creek dikes are classified as hypabyssal macrocrystic phlogopite kimberlites according to Clement et al. (1984). The kimberlites have distinct inequigranular textures characterized by macrocrysts and microcrysts set in an essentially microporphyritic groundmass. Olivine and phlogopite occur in at least two generations with olivine being the dominant mineral in both macrocryst and microcryst populations. The macrocrysts (2 mm to 1 cm) and microcrysts (1 to 2 mm) include serpentinized olivine pseudomorphs, chloritized phlogopites, kelyphitized garnets, magnesian ilmenites commonly with spinel and perovskite mantles and trace chrome diopsides. Deformation is evidenced by strained and kinked phlogopites, shattered garnets and subparallel tensional fractures within the macrocrysts. Primary groundmass minerals include phlogopite, serpentine (typically replaced by carbonate or silica), altered ilmenite and spinel, perovskite and apatite. The primary differences between the kimberlites are variations in their alteration and deformation characteristics.

The K-1 dike is classified as a carbonatized phlogopite kimberlite. Carbonates typically rim the macrocrysts, occur along crystallographic fractures in the macrocrysts and(or) have been introduced along tensional fractures in the macrocrysts. Groundmass carbonate is relatively abundant and has apparently replaced groundmass olivines and serpentine.

The K-2 and K-3 dikes (Fig. 1) are classified as silicified phlogopite kimberlites. The K-2 dike has a flow texture defined by the preferred alignment of altered and internally distorted ferromagnesian pseudomorphs. The K-3 kimberlite has a vuggy appearance due to the partial dissolution of microcrysts and macrocrysts. Relict olivine pseudomorphs in the K-3 dike are defined by their silicified oxide-rich anhedral to subhedral crystal outlines and void cores. Silica in both kimberlites has apparently replaced serpentines and to a lesser degree groundmass phlogopites. Prismatic and acicular groundmass apatites are more abundant in the K-2 and K-3 intrusions than in the K-1 kimberlite.

The kimberlite intrusions have been subjected to highly oxidizing conditions (M. McCallum, personal communication, 1986). Numerous primary ilmenites in the George Creek dikes have been converted to pseudobrookites and have textures similar to those described by Haggerty (1976) in the advanced oxidation stage of basaltic ilmenites. The pseudobrookites are commonly enriched in both chrome and(or) magnesium reflecting original kimberlitic ilmenite compositions. This feature is significant because pseudobrookite enriched in chrome and magnesium can be utilized as an additional kimberlite exploration indicator mineral in the George Creek region. Spinels in the George Creek kimberlites display atoll-type structures and are dominantly altered to titanomaghemites, perovskites and maghemites. Chrome spinels also occur in the kimberlites.

Whole rock geochemistry results of surficial kimberlite samples indicate that late-stage alteration processes (serpentinization, carbonatization, silicification and oxidation) apparently redistributed the more mobile major and compatible trace elements in the George Creek kimberlites. The incompatible trace elements which are less mobile and dominantly restricted to late-stage groundmass phases (Dawson, 1980; Mitchell, 1986) apparently discriminate the George Creek kimberlites. Dawson (1980) states that perovskite and apatite are the dominant host minerals for La and Th. Higher La and Th concentrations in the K-2 and K-3 dikes suggest that the two intrusions are enriched in perovskite and apatite relative to the K-1 dike. Perovskites, ilmenites and zircons in kimberlites are dominant host phases for Nb, Ta and Zr (Mitchell, 1986). The K-2 and K-3 dikes are enriched in Nb, Ta and Zr relative to the K-1 dike.

The George Creek K-1 diamond population is characterized by a high proportion of aggregates (23.5% in the -11+9 size range) relative to most reported diamondiferous kimberlites in Southern Africa (Whitelock, 1973; Robinson, 1979; Harris, et al., 1984). Orapa is the exception containing approximately 37% aggregates in the -11+9 size range (Robinson, 1979). Varations in diamond morphology with increasing stone size include higher proportions of aggregates and lower percentages of tetrahexahedra.

The diamond population is typified by a very high proportion of colourless stones (89.6% in -11+9 sieve class). The percentage of coloured diamonds appears to decrease with increasing size. Yellow and brown diamonds dominate within the coloured categories and comprise approximately 15 percent of the -9+7 size category.

Discovery of the George Creek kimberlite dikes was the culmination of detailed heavy mineral sampling, geophysical surveys and exploratory trenching. The intrusions are classified as hypabyssal macrocrystic phlogopite kimberlites and differ according to alteration, deformation and trace element chemistries. Diamond studies indicate that the George Creek kimberlites are typified by high proportions of colourless stones and crystal aggregates compared to most reported diamondiferous kimberlites.

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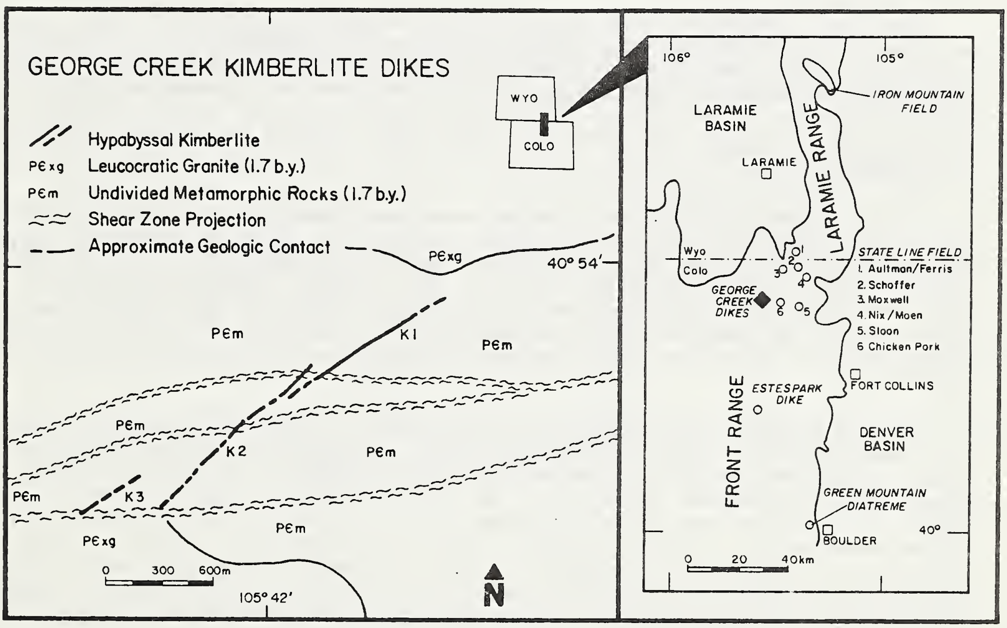

Figure 1: Location of the George Creek kimberlite dikes, Colorado, U.S.A.