Geology of the K6-252 Kimberlite Complex, Alberta, Canada

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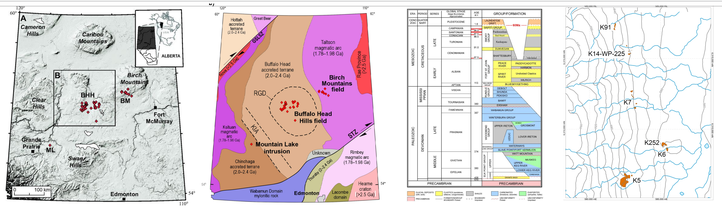
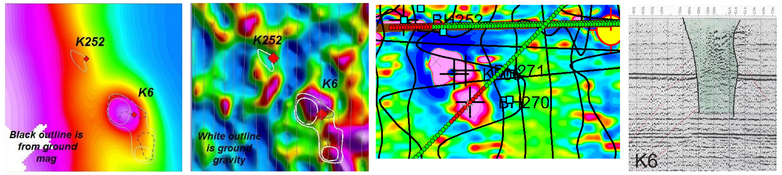
1. Introduction

The K6-252 kimberlite is part of the Buffalo Head Hills (BHH), the third largest district of diamond-bearing kimberlites in Canada, with 41 kimberlites distributed over 6,000km2. Systematic drilling by partners Canterra Minerals Corp. and Shore Gold Inc. recognized that several of the kimberlites are larger kimberlite complexes. The most conclusive modeling is for the K6 and K252 kimberlites, hereafter referred to as the K6-252 kimberlite complex.



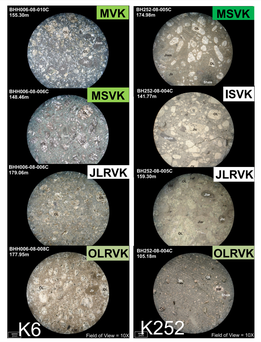
2. Regional and Local Geology

The BHH kimberlites are emplaced through the ~2.3Ga Buffalo Head Terrane, notably younger than Archean lithosphere that hosts diamondiferous kimberlites worldwide. Two kimberlite age groups are present; the ~85Ma Group and the ~60Ma Group. The K6-252 complex is ~85Ma and emplaced coevally with deposition of the late Cretaceous Dunvegan and Kaskapau Formations, then partially eroded in the Tertiary and subsequently buried under Quaternary glacial cover. All of the discoveries have been driven by geophysics. (Figures modified after Eccles, 2011;



3. Geophysics – Bodies Under Cover

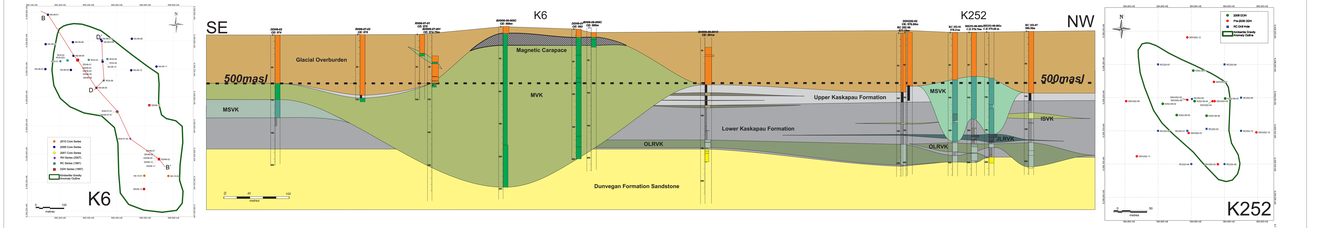
K6-252 exhibits a variety of geophysical signatures. Ground magnetics and gravity (overlain on airborne gravity) reveals the K6 vents in the left two images, but the K252 vent is magnetically invisible and detected only by ground gravity. The right two figures show that a northeast seismic line from historic oil and gas exploration indicates that the southern K6 vent extends to at least 250 meters depth.



Vent	Unit code	Volcaniclastic Kimberlite descriptor	Depositional setting	% of body vol%	olivine vol%	matrix vol%	lapilli vol%	basemnt vol%	carb vol%	sstone vol%	shale vol%
	MSVK	matrix-supported	vent	54.80	16	78	2	8	17	1	74
K252	OVK	other	interbedded	2.00	28	62	5	4	28	10	58
	ISVK	intersedimentary	interbedded	13.70	28	58	11	7	17	1	75
	JLRVK	juvenile lapilli-rich	interbedded	7.70	18	54	21	19	16	0	65
	OLRVK	olivine-rich	interbedded	21.70	29	55	12	5	14	0	81
	MVK-NW	main	vent	62.38	23	63	3	20	39	12	29
	MSVK-NW	matrix-supported	vent	10.35	24	71	3	26	25	0	49
K6	MVK-SE	main	vent	10.03	23	63	3	20	39	12	29
	MSVK-SE	matrix-supported	vent	11.60	24	71	3	15	26	31	28
	JLRVK	juvenile lapilli-rich	interbedded	3.45	32	53	12	20	19	2	59
	OLRVK	olivine-rich	interbedded	2.19	33	63	3	51	16	0	33

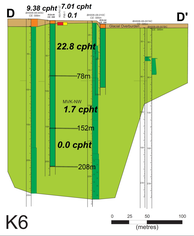
4. Detailed Core Logging and Petrography

Drill core from both the most recent programme as well as historic core and core logs were examined in detail to conduct the modeling exercise. Detailed logging of core included line-scan modal analyses as well as petrography and whole rock geochemistry. While all of the rocks could be classified as volcaniclastic kimberlite (VK), it became apparent that both vent and interbedded kimberlite is present. Each vent of the K6-252 complex has its own eruptive history. K6 has more complex vent deposits, whereas K252 has a greater variety of interbedded deposits (see table above, images to the left), but both vent systems are connected.



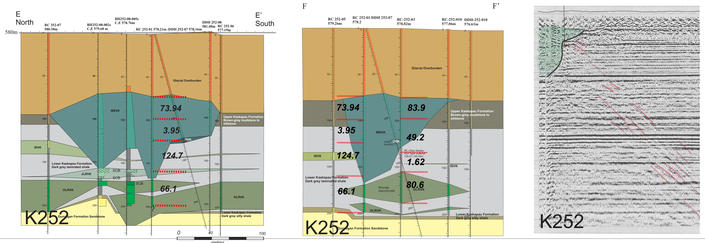
5. Geologic Cross-Sections

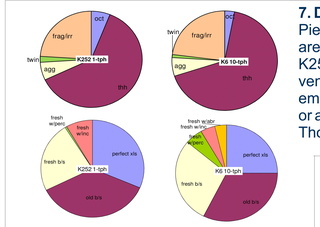
Plan maps for K6 (left) and K252 (right) reference sections and fence diagrams that follow. Section line B-B' from K6 and E-E' from K252 are combined to make the SE-NW fence diagram shown in the centre. The diagram is drawn with the 500masl datum as a common reference point, shown by the dashed line. Both vents record their own history, but they are linked by the interbedded OLRVK deposited at the base of the Lower Kaskapau Formation. Thickening of the OLRVK and coarser olivine nearer K252 suggest that it was the primary vent source for the OLRVK. The depth of the vents is not confirmed by drilling, but indicated by seismic sections (see section 3 for K6, right image below for K252).



6. Diamond Sample Grades

Overall grades for K6 and K252 are ~7cpht and ~55cpht, respectively, but both vents exhibit variable grades at the sample size of 1-2 tonnes. For K6 (left, bold numbers) grades vary from nil to 23cpht, including bulk sample surface pitting. K252 (right) ranges from ~1cpht to 124cpht, depending on the unit sampled. What is notable is that the OLRVK has sample grades of 66-81cpht, making this interbedded unit of economic interest.



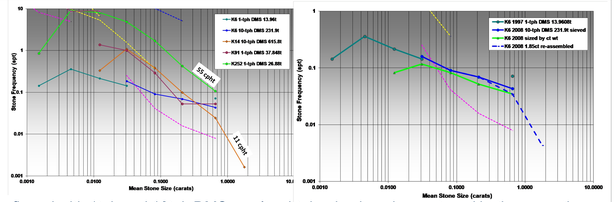


7. Diamond Morphology

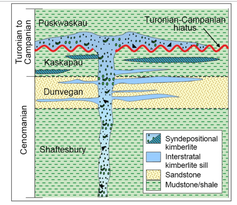
Pie charts to the upper left indicate the DMS plant that treated the kimberlite in the center of each pie, in tonnes per hour (tph). Diamond codes are: oct = octahedra; thh = tetrahexahedroida; agg = aggregate; twin = macle; frag/irr = fragment/irregular (usually resorbed fragments). K6 and K252 are nearly identical, even with the diamonds being recovered from different DMS plants. Lower left charts compare breakage for the two vents. Natural stones are either perfect crystals (xls) or have old breakage surfaces (b/s) formed in the kimberlite. Fresh breakage is post-emplacement and may have evidence for a natural cause, such as inclusions (w/inc), or a mechanical cause such as percussion marks (w/perc) or abrasion (w/abr). Fresh breakage from mechanical causes is not significant in either body, although a 1.85ct gem makeable was broken in K6. Though not shown here, the data indicate that K6 contains a higher proportion of high-quality makeable white and yellow stones relative to K252.

8. Diamond Size Frequency Distribution (SFD)

The upper left graph shows SFD curves for DMS data from K6-252 vs K91 and K14, two other BHH kimberlites. Dashed lines are 100cpht (blue) and 1cpht (pink) reference curves. K252 with a ~55 cpht sample grade sits above the 11cpht K14 as expected, but with a similar slope. With a sample grade of only 7cpht, DMS results for K6 plot lower, but the slope is much flatter.

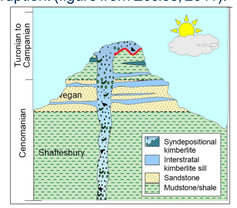


This anomalously flat SFD is independently confirmed with 1tph and 10tph DMS results obtained a decade apart, and both suggesting a coarse diamond size distribution. The most recent DMS data were re-assessed using stone weights but the same slope was obtained (green line), suggesting that the slope is natural and not a man-caused artefact. The dashed blue line indicates a curve change after the 1.85ct stone is re-assembled, but this change alone does not detract from the implication that coarse diamonds will be recovered with larger DMS test samples from K6. A selection of stones recovered to date from K6 is shown on the left image.



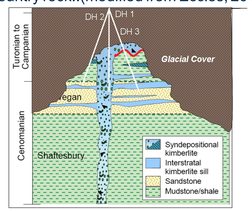
9. 90-85 Myrs – Emplacement

Cartoon depiction of K6-252 eruption and burial in Turonian to Campanian time. Red line indicates depositional break at the time of eruption. (figure from Eccles, 2011).



10. 85-3 Myrs – Erosion

Tertiary erosion creates positive topography for the kimberlite feeders relative to the softer country rock..(modified from Eccles, 2011).



11. 3-0 Myrs – Burial

Quaternary till deposition buries the Tertiary topography with little modification, leaving BHH kimberlites as positive features under overburden of variable thickness. Historic drilling (DH) focused on testing geophysical targets with multiple holes from one collar; the systematic vertical drilling presented here was necessary to accurately resolve the geological relations. .(modified from Eccles, 2011).

References
Chen, D. and Olson, R. 2005. Regional stratigraphic framework of Buffalo Head Hills-Peerless Lake Region, northern Alberta. EUB/AGS Earth Sciences Report 2005-05, Alberta Geological Survey, 47p. Eccles, D.R. 2011. Northern Alberta kimberlite province: the first 20 years. Energy Resources Conservation Board, ERCB/AGS Bulletin 65, 116p. Paulen, R. and McClenaghan, M.B. 2015. Late Wisconsin ice-flow history in the Buffalo Head Hills kimberlite field, north-central Alberta. Canadian Journal of Earth Science 52, 51-67.