THE EVALUATION OF OLIVINE SAND PREPARED FROM TULAMEEN DUNITE* (92H/10)

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INTRODUCTION

A geological mapping and sampling program carried out during 1986 identified three zones of fresh dunite (loss on ignition less than 2 per cent) in the core of the Tulameen ultramafic complex (White, 1986). Following this survey, a 20-kilogram sample of dunite was collected from one of the zones (Figure 3-4-1) and sent to the CANMET/Energy, Mines and Resources laboratories in Ottawa for physical tests to determine if the dunite would meet commercial specifications for foundry sand applications. Encouraging preliminary results (Szabo *et al.*, 1987) prompted the collection, during the 1987 field season, of a 300-kilogram bulk sample of dunite to verify its suitability as a foundry-grade olivine sand which would be competitive with imported sands. The sample was forwarded to the CANMET laboratories in Ottawa to undergo the full-scale testing required to evaluate a potential foundry sand.

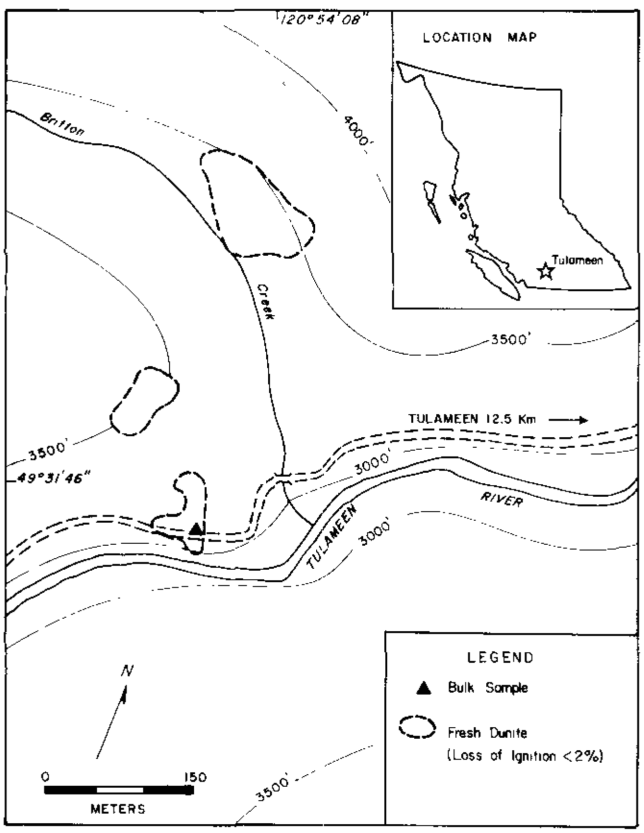

Figure 3-4-1. Location of "fresh" zones of dunite, Tulameen ultramafic complex.

SAMPLE PREPARATION

The 300-kilogram bulk sample consisted of rock fragments 10 to 15 centimetres in diameter. In order to determine optimal breakdown of the dunite and to produce sand-sized particles, three crushing modes, jaw plus rolls, hammer mill and pin mill, were employed. As a first step, the dunite was crushed to 2.5 centimetres by a large jaw crusher. Three corresponding 25-kilogram head samples designated A, B and C were then treated as follows:

(1) Sample A: stage-crushed and screened to 8 mesh by jaw crusher (2 passes) and roller (1 pass).

(2) Sample B: crushed to 8 mesh in pin mill (1 pass).

(3) Sample C: crushed to 8 mesh in hammer mill with 4.125-millimetre (1/8-inch) slotted grate.

Sieve analysis (Table 3-4-1) indicates that the hammer mill is the preferred crushing method for optimum production and recovery of −20+100-mesh product. On this basis the remainder of the 2.5-centimetre jaw-crusher product was crushed in the hammer mill, screened on a Rotex screen at 20 and 100 mesh, the product blended and sampled, and five 40-kilogram samples selected for foundry evaluation. The results of a sieve analysis on the five blended samples are summarized in Table 3-4-2. The five samples were then forwarded for the foundry-sand evaluation tests.

TABLE 3-4-1
SIEVE ANALYSES FROM THE THREE CRUSHING PROCESSES
(from Whiting *et al.*, 1987)

Mesh Size	Head Sample	Sample A* (Jaw + Rolls) 15 min.	30 min.	Sample B* (Pin Mill) 15 min.	30 min.	Sample C* (Hammer Mill) 15 min.	30 min.
+4	57.6						
−4, +8	17.0						
−8, +14	6.4						
−14, +20	2.4	30.6	30.8	14.5	14.0	18.7	18.7
−20, +28		12.9	12.6	7.4	7.4	8.6	8.6
−28, +35		10.6	11.5	10.1	10.2	10.9	10.7
−35, +48	11.6	9.4	9.3	13.3	13.3	13.7	13.5
−48, +65		8.3	8.1	14.7	15.1	14.1	14.1
−65, +100		7.6	7.6	14.3	14.1	13.1	12.9
−100	5.0	20.6	20.1	25.7	25.9	20.9	21.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* 15 and 30 min. Retap intervals.

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

TABLE 3-4-2
SIEVE ANALYSES — BLENDED SAMPLES FOR FOUNDRY EVALUATION (Wt. %)
(from Whiting *et al.*, 1987)

Mesh Size	IMC Olivine	*	Tulameen Olivine **	***
+28	6.9	7.8	7.8	9.4
−28, +35	27.4	18.7	18.7	22.6
−35, +48	28.3	23.5	23.5	28.4
−48, +65	29.0	24.3	24.3	29.3
−65, +100	7.3	19.0	6.3	7.6
−100	1.1	6.7	2.2	2.6
	100.0	100.0	100.0	100.0

* Hammer mill product screened at 20 and 100 mesh on Rotex.
** Product screened at 65 mesh, ⅓ of minus 65 reblended, remaining ⅔ discarded.
*** Calculated sieve analysis of screened and reblended sample.

TABLE 3-4-4
EVALUATION OF SCAB BLOCK CASTINGS*
(from Whiting *et al.*, 1987)

Casting Property	Sand Type	Casting Trial Number 1	2	3	4	5
Surface finish	IMC olivine	3	3	3	3	2
	Tulameen olivine	3	3	3	3	2
Scabbing	IMC olivine	1	1	1	1	1
	Tulameen olivine	1	1	1	1	1
Burn on	IMC olivine	2	2	2	2	2
	Tulameen olivine	2	2	2	2	2
Erosion	IMC olivine	2	2	2−	2	2
	Tulameen olivine	2	2	2	2	2
Penetration	IMC olivine	2	2	2	2	2
	Tulameen olivine	2	2	2	2	2

* Each casting was rated subjectively for each property for every trial, using a scale of 1 to 5, where 1 = good and 5 = bad.

TABLE 3-4-3
GREENSAND PROPERTIES BEFORE AND AFTER EACH TRIAL
(from Whiting *et al.*, 1987)

Casting Property	Sand Type		Casting Trial Number 1	2	3	4	5
Sand Properties Before Each Casting Trial							
Compactability %	IMC olivine		44	45	48	44	49
	Tulameen olivine		49	47	45	45	49
Moisture %	IMC olivine		2.15	2.15	2.24	2.20	2.15
	Tulameen olivine		2.16	2.21	2.14	2.13	2.23
Density, g/cm³	IMC olivine		195	195	193	192	190
	Tulameen olivine		186	185	185	185	183
Permeability, AFS units	IMC olivine		200	195	210	215	228
	Tulameen olivine		249	240	240	243	253
Green compressive strength, psi	IMC olivine		30.0	27.1	29.0	30.2	28.9
	Tulameen olivine		25.7	25.2	28.0	29.6	28.6
Clay additions, %	IMC olivine		6.0	0.1	0.1	0	0
	Tulameen olivine		6.0	0.3	0.15	0.05	0.2
Methylene blue clay, %	IMC olivine		6.1	6.1	6.3	5.8	5.8
	Tulameen olivine		6.1	6.1	6.2	6.0	5.8
Mould hardness, B scale	IMC olivine		88	88	88	90	88
	Tulameen olivine		88	88	90	90	88
AFS grain fineness number, AFS units	IMC olivine		42.7				*50.6
	Tulameen olivine		44.3				*54.5
Acid demand, ml	IMC olivine	at pH 5	9.6				
		at pH 7	8.5				
	Tulameen olivine	at pH 5	33.6				
		at pH 7	30.5				
Loss on ignition, %	IMC olivine	at 500°C	0.55				
		at 700°C	1.25				
		at 975°C	1.51				
	Tulameen olivine	at 500°C	0.90				
		at 700°C	1.82				
		at 975°C	1.83				
After Casting Trials							
Moisture, %	IMC olivine		0.85	0.82	0.94	0.81	N/D
	Tulameen olivine		0.93	0.83	0.98	0.85	N/D
Methylene blue clay, %	IMC olivine		5.9	5.9	6.1	6.1	N/D
	Tulameen olivine		5.7	5.9	5.6	5.8	N/D
AFS clay, %	IMC olivine		N/D	N/D	N/D	N/D	8.96
	Tulameen olivine		N/D	N/D	N/D	N/D	8.48

* After fifth trial and after washing for AFS clay test.

FOUNDRY TESTING

Evaluation of the Tulameen olivine sand samples was done by comparing the casting performance using Hadfield manganese steel "scab blocks" as a test casting, with a widely used and available standard foundry sand (IMC Olivine 50). Such testing follows 14 specific steps according to standard foundry-sand tests as recommended and defined by the American Foundrymen's Society. The resulting values for individual casting properties of sand are presented in Table 3-4-3 and the evaluation of scab-block castings in Table 3-4-4. With the exception of using some specialty chemical binder systems, the Tulameen dunite foundry sand compares favourably with the imported product, both in moulding performance and casting quality.

SUMMARY

Although limited in extent, the results of the detailed mapping of the least serpentinized part of the Tulameen ultramafic complex, followed by comprehensive laboratory testing, give a good indication that the Tulameen dunite is suitable for the production of foundry sand which is at present imported to Canada with other olivine rock products from the United States.

ACKNOWLEDGMENTS

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REFERENCES

Szabo, E.I. and Kular, A.C. (1987): Evaluation of Olivine Type Sand Sample for Foundry Use, Physical Metallurgy Research Laboratories, *CANMET/Energy Mines and Resources*, Ottawa, Unpublished Report, PMRL 87-20 (INT).

White, G.V. (1987): Olivine Potential in the Tulameen Ultramafic Complex, Preliminary Report, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 303-307.

Whiting, L.V., Warda, R.D., Collings, R.K. and Darke, E.F. (1987): Evaluation of Olivine Sand from Grasshopper Mountain, Princeton, British Columbia, Physical Metallurgy Research Laboratories, *CANMET/Energy Mines and Resources*, Ottawa, Unpublished Report, MRP/PMRL 87-24(CF).