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Maceral types in some Permian southern African coals

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ABSTRACT

A suite of Permian Gondwana coals from southern Africa, exclusive of the Republic of South Africa, were examined petrographically. With the exception of a single low volatile bituminous/semi-anthracite coal from Mozambique, the coal rank is high volatile bituminous C. Most coals were dominated by inertinite-group macerals, primarily semifusinite and detrital inertinite (inertodetrinite), but with significant secretinite in some cases. Vitrinite-group macerals were absent in several Zambian coals. When considering these coals, it becomes apparent that not all Gondwana maceral types determined necessarily fit the ICCP definitions.

1. Introduction

Gondwana Permian coals of southern Africa are known, generally, to be inertinite-rich (with some exceptions), and are typically bituminous C coals (ISO, 11760, 2005), although there are localized areas containing Bituminous B and anthracites derived from thermal and contact metamorphism (Cairncross, 2001; Synman and Barclay, 1989). Published petrographic information (from a geological and petrological perspective rather than an applied perspective) pertaining to South African coals is far more diverse (Catuneanu et al., 2005; Fabiańska and Kruszewska, 2003; Falcon, 1986, 1989; Falcon and Ham, 1988; Falcon and Snyman, 1986; Faure et al., 1996; Glasspool, 2003; Hagelskamp and Snyman, 1988; Kruszewska, 2003; Mackowsky, 1973; Snyman and Botha, 1993; Stavrakis and Smyth, 1991; Synman and Barclay, 1989) when compared to the other southern African countries, namely Botswana, Malawi (Bennet, 1989), Namibia, Swaziland, Zambia (Money and Drysdall, 1973; Utting and Wielens, 1992), Mozambique (Falcon et al., 1984; Vasconcelos, 1995; Vasconcelos and Santos, 1989), Tanzania (Diekmann and Wopfner, 1996; Kalkreuth et al., 1999; Semkiwa et al., 1998, 2003), and Zimbabwe (Duguid, 1978; Oesterlen and Lepper, 2005; Watson, 1958). However, there are limited recent articles on coal petrography from the subcontinent in general.

Cairncross (2001) provides an eloquent overview of the Permian coal deposits of southern Africa, including Botswana, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. Detailed coal petrology is not discussed, although Catuneanu et al. (2005) and Cairncross (2001) provide basic coal qualities along with lithostratigraphic units. A detailed photographic series of petrographic constituents in southern African coals can be found in Falcon and Snyman (1986). A limited amount of information pertaining to the petrographic composition of southern African coals is being generated and occasionally presented at local conferences (largely run by the Fossil Fuel Foundation of South Africa), but most information is retained in company and in a few open-file reports; this information is not necessarily available to an international audience in the form of peer-reviewed publications. Readers unfamiliar with petrographic terminology should refer to Falcon and Snyman (1986), Stach (1982), Taylor et al. (1998), or ICCP (1998, 2001).

In this paper coal macerals from southern African samples (excluding South Africa), acquired by the United States Geological Survey (USGS) as part of their World Coal Quality Inventory project (Tewalt et al., 2010), are considered. The samples originated from Botswana, Mozambique, Tanzania, and Zambia, and are indicative of coals in the region, but are certainly not exhaustive. Generation of petrographic

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Table 1
Macerals, maceral groups, minerals, and vitrinite maximum and random reflectances. The columns in italics represent the sum of the maceral subgroups within the vitrinite group macerals and the sum of the maceral groups, otherwise.

			Telinite	Collotelinite	*Telovitrinite*	Vitrodetrinite	Collodetrinite	*Detrovitrinite*	Corpogelinite	Gelinite	*Gelovitrinite*
Mozambique	Moz 1	Moatize	0.8	51.6	*52.4*	15.2	0.0	*15.2*	1.2	0.0	*1.2*
			0.9	56.6	*57.5*	16.7	0.0	*16.7*	1.3	0.0	*1.3*
Botswana	Bot 01	Morupule 0–0.95	2.6	0.6	*3.2*	1.4	0.0	*1.4*	0.0	0.0	*0.0*
			2.8	0.6	*3.4*	1.5	0.0	*1.5*	0.0	0.0	*0.0*
	Bot 04	Morupule 0.95–1.55	1.6	0.6	*2.2*	1.0	0.0	*1.0*	0.4	0.0	*0.4*
			1.7	0.6	*2.3*	1.1	0.0	*1.1*	0.4	0.0	*0.4*
	Bot 02	Morupule 1.55–2.1	1.4	0.6	*2.0*	0.8	0.0	*0.8*	0.0	0.0	*0.0*
			1.5	0.7	*2.2*	0.9	0.0	*0.9*	0.0	0.0	*0.0*
	Bot 03	Morupule 2.1–2.85	4.8	1.0	*5.8*	1.0	0.0	*1.0*	0.4	0.0	*0.4*
			5.2	1.1	*6.3*	1.1	0.0	*1.1*	0.4	0.0	*0.4*
	Bot 05	ROM 1A	2.6	1.6	*4.2*	1.2	0.0	*1.2*	0.6	0.0	*0.6*
			3.0	1.8	*4.8*	1.4	0.0	*1.4*	0.7	0.0	*0.7*
	Bot 06	ROM 1B	4.4	1.0	*5.4*	1.8	0.2	*2.0*	0.6	0.0	*0.6*
			4.8	1.1	*5.9*	2.0	0.2	*2.2*	0.7	0.0	*0.7*
	Bot 07	ROM 2A	2.6	1.0	*3.6*	1.2	0.0	*1.2*	0.0	0.0	*0.0*
			3.0	1.2	*4.2*	1.4	0.0	*1.4*	0.0	0.0	*0.0*
	Bot 08	ROM 2B	2.6	1.0	*3.6*	1.4	0.0	*1.4*	0.0	0.0	*0.0*
			2.9	1.1	*4.0*	1.6	0.0	*1.6*	0.0	0.0	*0.0*
	Bot 09	ROM 2C	4.8	2.0	*6.8*	0.4	0.0	*0.4*	0.2	0.0	*0.2*
			5.6	2.3	*8.0*	0.5	0.0	*0.5*	0.2	0.0	*0.2*
	Bot 10	ROM 3A	4.4	1.6	*6.0*	0.6	0.0	*0.6*	0.0	0.0	*0.0*
			5.0	1.8	*6.9*	0.7	0.0	*0.7*	0.0	0.0	*0.0*
	Bot 11	ROM 3B	2.2	1.4	*3.6*	0.4	0.0	*0.4*	0.2	0.0	*0.2*
			2.5	1.6	*4.1*	0.5	0.0	*0.5*	0.2	0.0	*0.2*
Tanzania	KCM TZ-01		6.6	8.2	*14.8*	4.0	0.0	*4.0*	0.0	0.0	*0.0*
			7.6	9.4	*17.0*	4.6	0.0	*4.6*	0.0	0.0	*0.0*
	KCM TZ-02		2.8	49.6	*52.4*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			3.0	53.4	*56.5*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	KCM TZ-03		5.2	21.8	*27.0*	4.2	0.4	*4.6*	0.0	0.0	*0.0*
			6.4	26.9	*33.3*	5.2	0.5	*5.7*	0.0	0.0	*0.0*
	KCM TZ-04		1.6	2.6	*4.2*	1.2	0.4	*1.6*	0.0	0.0	*0.0*
			2.2	3.6	*5.8*	1.7	0.6	*2.2*	0.0	0.0	*0.0*
	KCM TZ-05		7.6	29.8	*37.4*	8.6	0.4	*9.0*	1.8	0.0	*1.8*
			8.3	32.6	*40.9*	9.4	0.4	*9.8*	2.0	0.0	*2.0*
Zambia	Zam 3	Izuma	3.0	1.2	*4.2*	0.6	0.0	*0.6*	0.2	0.0	*0.2*
			3.2	1.3	*4.4*	0.6	0.0	*0.6*	0.2	0.0	*0.2*
	Zam 4	Izuma	2.8	3.8	*6.6*	0.4	0.2	*0.6*	0.4	0.0	*0.4*
			2.9	3.9	*6.7*	0.4	0.2	*0.6*	0.4	0.0	*0.4*
	Zam 5	Izuma	t	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			t	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	Zam 6	Izuma	0.2	1.4	*1.6*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			0.2	1.5	*1.7*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	Zam 7	Izuma	3.4	3.4	*6.8*	2.8	0.2	*3.0*	0.6	0.0	*0.6*
			3.6	3.6	*7.1*	2.9	0.2	*3.1*	0.6	0.0	*0.6*
	Zam 8	Izuma	1.8	3.2	*5.0*	2.8	0.0	*2.8*	0.0	0.0	*0.0*
			1.9	3.3	*5.2*	2.9	0.0	*2.9*	0.0	0.0	*0.0*
	Zam 9	Izuma	1.2	1.4	*2.6*	0.8	0.0	*0.8*	0.4	0.0	*0.4*
			1.3	1.5	*2.8*	0.9	0.0	*0.9*	0.4	0.0	*0.4*
	Zam 10	Izuma Mudala	0.2	1.8	*2.0*	0.6	0.0	*0.6*	0.2	0.0	*0.2*
			0.2	2.0	*2.3*	0.7	0.0	*0.7*	0.2	0.0	*0.2*
	Zam 11	Izuma Mudala	0.2	0.2	*0.4*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			0.3	0.3	*0.5*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	Zam 12	Izuma Mudala	0.0	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			0.0	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	Zam 13	Izuma Mudala	0.0	0.2	*0.2*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			0.0	0.2	*0.2*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
	Zam 14	Izuma Mudala	1.8	3.0	*4.8*	4.0	0.0	*4.0*	0.2	0.0	*0.2*
			1.9	3.2	*5.1*	4.2	0.0	*4.2*	0.2	0.0	*0.2*
	Zam 15	Izuma Mudala	t	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*
			t	0.0	*0.0*	0.0	0.0	*0.0*	0.0	0.0	*0.0*

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2. Procedure

Coal pellets for petrographic examination were prepared according to ISO standard 7404 part 2. Epoxy-bound particulate pellets of the southern African coals were prepared to a final 0.5-μm polish and examined with white light and blue-light excitation using 50×, reflected-light oil-immersion objectives on Leitz Orthoplan microscopes.

3. Results and discussion

3.1. Maceral descriptions

The maceral content and vitrinite maximum and mean random reflectance for the coals are given in Table 1, and the basic chemistry,