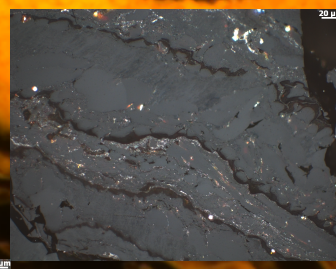
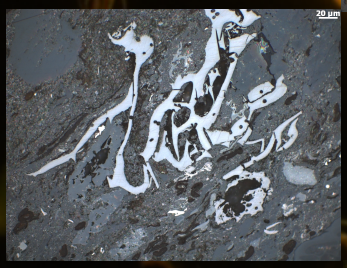
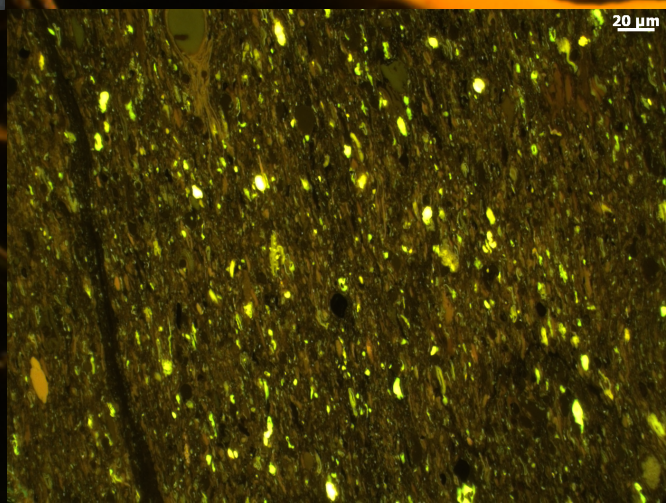
USGS

Petrographic and vitrinite reflectance analyses of a suite of high volatile bituminous coal samples from the United States and Venezuela







Open-File Report 2008-1230

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
Dirk A. Kempthorne, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia 2008

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth,
its natural and living resources, natural hazards, and the environment:
World Wide Web: http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested citation:
Hackley, P.C., Kolak, J.J., 2008, Petrographic and vitrinite reflectance analyses of a suite of high volatile bituminous coal samples from the United States and Venezuela: U.S. Geological Survey Open-File Report 2008-1230, 36 p., *http://pubs.usgs.gov/of/2008/1230*.

Contents

Introduction 1
Methods 1
Sample Collection 1
Sample Preparation 1
Vitrinite Reflectance 1
Organic Composition 2
Data Quality 2
Results 3
Vitrinite Reflectance 3
Acknowledgements 5
References 6

Figures

Map showing sample locations 2
Photomicrographs 4

Tables

Table 1. Vitrinite reflectance and maceral group composition 2
Table 2. Petrographic data on volume percent whole coal basis 5
Table 3. Comparison of data from previous petrographic analyses with this study 5

Appendix

Vitrinite reflectance and organic composition data 7

Petrographic and vitrinite reflectance analyses of a suite of high volatile bituminous coal samples from the United States and Venezuela

By Paul C. Hackley and Jonathan J. Kolak

U.S. Geological Survey, MS 956 National Center, Reston, VA 20192

Introduction

This report presents vitrinite reflectance and detailed organic composition data for nine high volatile bituminous coal samples. These samples were selected to provide a single, internally consistent set of reflectance and composition analyses to facilitate the study of linkages among coal composition, bitumen generation during thermal maturation, and geochemical characteristics of generated hydrocarbons. Understanding these linkages is important for addressing several issues, including: the role of coal as a source rock within a petroleum system, the potential for conversion of coal resources to liquid hydrocarbon fuels, and the interactions between coal and carbon dioxide during enhanced coalbed methane recovery and(or) carbon dioxide sequestration in coal beds. Several recent studies have utilized detailed information on coal maceral composition to refine the understanding of these linkages (Petersen and Rosenberg, 2000; Karacan and Mitchell, 2003; Mastalerz and others, 2004; Kalaitzidis and others, 2006).

The nine isorank samples characterized in this study differ in geographic location, timing of deposition, and organic matter composition. Five Pennsylvanian coal samples from the Illinois, Appalachian, and Black Warrior basins, USA, two Paleocene and one Eocene-Oligocene coal samples from the Maracaibo basin, Venezuela, and one Eocene coal sample from the Gulf of Mexico Coastal Plain, USA, comprise the sample set (Table 1; fig. 1). All original petrographic data for the samples are included in the Appendix to this report. Results from proximate-ultimate analyses are given in earlier publications (Mastalerz and others, 2004; Kolak and Burruss, 2006; Hackley and others, 2005; Hackley and Martínez, 2007).

Methods

Sample Collection

Mine channel samples of the three Venezuelan coals, the Santo Tomas coal (Gulf of Mexico basin, USA), and the Indiana, Ohio, and Alabama coals were collected according to American Society for Testing and Materials (ASTM) D 4596: Practice for collection of channel samples in a mine (ASTM, 2007). The Cedar Grove sample from West Virginia was collected from core according to ASTM D 5192: Practice for collection of coal samples from core (ASTM, 2007).

Sample Preparation

Samples were prepared for analysis according to ASTM D 2797: Preparing coal samples for microscopical analysis by reflected light (ASTM, 2007). Samples were ground to pass a 850-µm (No. 20 mesh) sieve and mounted in 1-inch molds using a heat-setting thermoplastic powder or epoxy resin medium. Two mounts were made for each sample. Examination surfaces were ground and polished, then desiccated overnight prior to reflectance and compositional analysis.

Vitrinite Reflectance

Determinations of mean random (R_o) and mean maximum (R_{max}) vitrinite reflectance were

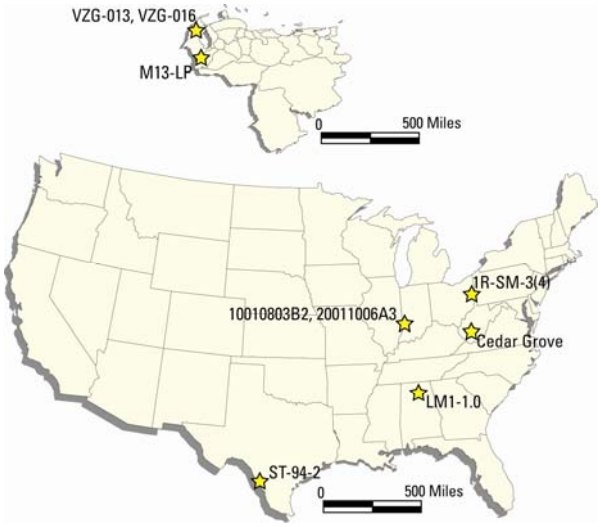


Figure 1. Maps of United States and Venezuela showing locations of coal sample collection.

conducted according to ASTM D 2798: Microscopical determination of the vitrinite reflectance of coal (ASTM, 2007). A Leica DMRX microscope equipped with a J&M MSP-200 photomultiplier system was used for most of the measurements. A Leitz Orthoplan microscope equipped with a MPV II photomultiplier system was used for random reflectance measurements of some samples (see website http://energy.er.usgs.gov/coal_studies/organic_petrology/laboratory.html for details of the microscope systems). One hundred measurements of reflectance of individual vitrinite fragments of all types were performed as prescribed by ASTM (2007). Maximum reflectance was not determined for sample M13-LP (Table 1) from the La Pajarita mine in Venezuela (Hackley and others, 2005) due to paucity of homogenous vitrinite suitable for measurement.

Organic Composition

Coal samples were analyzed for organic composition according to ASTM D 2799: Microscopical determination of the maceral composition of coal (ASTM, 2007). One thousand identifications of organic material and mineral matter were performed per sample; five hundred identifications were performed on each mount. A modification of ASTM D 2799 using fluorescence microscopy was employed for the two liptinite-rich samples (sample ST-94-2, Santo Tomas coal, and sample M13-LP, La Pajarita mine, Venezuela) to include two thousand identifications of organic material and mineral matter (one thousand identifications in white light and one thousand in blue light). Maceral nomenclature for the vitrinite and inertinite maceral groups is according to the International Committee for Coal and Organic Petrology (ICCP) (ICCP, 1998, 2001). Although random reflectance values for two of the samples fall below 0.5 %, the huminite classification scheme (Sýkorová and others, 2005) was not used herein so that the same terminology was applied consistently for the entire sample suite. Maceral nomenclature for the liptinite group is according to Taylor and others (1998).

Data Quality

The U.S. Geological Survey Organic Petrology Laboratory participates in a quarterly round robin interlaboratory exercise hosted by a

								Volume% Whole Coal					No.
Sample ID	Age	Basin	State	R_o	s.d.	R_{max}	s.d.	%Vit	%Inert	%Lip	%Min*	%Min**	Counts
20010803B2	Pennsylvanian	Illinois	Indiana	0.48	0.04	0.54	0.03	78.2	7.4	11.0	3.4	2.5	1000
ST-94-2	Eocene	Gulf Coast	Texas	0.48	0.06	0.55	0.06	69.9	1.9	18.3	9.9	5.9	2000
M13-LP	Eocene-Oligocene	Maracaibo	Tachira	0.52	0.07	n.d.	n.d.	28.4	0.9	66.3	4.4	2.1	2000
20011006A3	Pennsylvanian	Illinois	Indiana	0.61	0.05	0.67	0.05	83.8	7.0	4.5	4.7	3.6	1000
VZG-013	Paleocene	Maracaibo	Zulia	0.66	0.03	0.67	0.04	78.0	18.5	2.1	1.4	0.6	1000
1R-SM-3(4)	Pennsylvanian	Appalachian	Ohio	0.68	0.04	0.81	0.03	63.9	22.0	7.6	6.5	3.2	1000
VZG-016	Paleocene	Maracaibo	Zulia	0.78	0.05	0.78	0.04	68.8	28.1	0.8	2.3	1.2	1000
LM1-1.0	Pennsylvanian	Black Warrior	Alabama	0.82	0.04	0.89	0.03	80.1	6.9	4.2	8.8	8.6	1000
Cedar Grove	Pennsylvanian	Appalachian	West Virginia	0.91	0.04	0.95	0.04	67.8	24.0	5.7	2.5	2.4	1000

R_o = mean random reflectance of vitrinite, R_{max} = mean maximum reflectance of vitrinite, n.d. = not determined, * = determined from mineral-inclusive point count, ** = calculated per Parr formula (ASTM, 2007).

Table 1. Vitrinite reflectance and maceral group composition.

commercial laboratory (CoalTech Petrographic Associates, Inc.). Results of the exercise are used to evaluate the precision and bias of our analytical methods, to develop proficiency in analyses of different sample types, to correct deficiencies in analytical techniques, and to develop evidence of the repeatability and reproducibility of analytical methods. In addition, the U.S. Geological Survey Organic Petrology Laboratory maintains accreditations in methods of coal and dispersed organic matter petrographic analysis from the International Committee for Coal and Organic Petrology. Accreditation information, certificate number, and expiration date are given in the footer material of individual sample reports and are available from the laboratory webpage.

Results

Vitrinite Reflectance

Mean random reflectance of vitrinite ranges 0.48-0.91 % and mean maximum reflectance ranges 0.54-0.95 %, indicating coal rank of high volatile bituminous (Taylor and others, 1998). Samples are arranged in order of increasing mean random reflectance values in Table 1. Maximum reflectance values generally are slightly higher (0.04-0.07 %) than random reflectance with the exception of the two Paso Diablo samples from Venezuela (sample IDs VZG-013 and VZG-016; Hackley and Martínez, 2007), where random and maximum reflectance are approximately equivalent. In addition, the Ohio coal sample, 1R-SM-3(4), contains strongly anisotropic vitrinite and the difference between mean random and mean maximum reflectance is 0.13 %. Bireflectance generally is absent in vitrinite in the lower reflectance coal samples from the Illinois basin (sample IDs 20010803B2 and 20011006A3), the Gulf Coast (Sample ID ST-94-2), and the La Pajarita mine in western Venezuela (Sample ID M13-LP). High structural variation in the vitrinite of these samples (fig. 2A) primarily is responsible for consistently higher maximum than random reflectance values, that is, different types of vitrinite were unavoidably measured during a single stage rotation.

Organic Composition

With the exception of the sapropelic coal (M13-LP) from Venezuela (Hackley and others, 2005), the organic composition of the samples is dominated by vitrinite macerals (Tables 1 and 2). On a whole coal basis (inclusive of mineral matter) vitrinite content ranges from 28.4 volume percent (vol.%) in the sapropelic coal to 83.8 vol.% in one of the Illinois basin samples (20011006A3). The Paso Diablo coal samples contain extremely low mineral matter content, high total inertinite, and high detrovitrinite (fig. 2B) relative to telovitrinite (fig. 2C), characteristics interpreted to indicate deposition in an ombrogenous raised mire (Hackley and Martínez, 2007). The other humic coal samples of this study contain a two-to-one or better ratio of telovitrinite to detrovitrinite indicative of generally rapid subsidence/burial and preservation of organic material. Low concentrations of detrital macerals (such as inertodetrinite and liptodetrinite) also support this interpretation with the exception of the relatively liptinite-rich Santo Tomas coal which contains some sapropelic facies (Warwick and Hook, 1995).

Total inertinite content ranges from 0.9 vol.% in the sapropelic coal to 28.1 vol.% in one of the Paso Diablo coals. Inertinite content in Illinois basin sample 20010803B2 is dominated by micrinite (fig. 2D) with traces of inertodetrinite; micrinite also is the predominant inertinite maceral in the Ohio coal sample (fig. 2E). Semifusinite also is an important component of the inertinite maceral group in the samples of this study, particularly in the Paso Diablo coals and in the Cedar Grove coal from West Virginia. Funginite is present only in the Tertiary coal samples (fig. 2F).

Liptinite content is highest in the sapropelic coal (M13-LP) from Venezuela, where total liptinite content is 66.3 vol.%. An amorphous, faintly fluorescent bituminite groundmass is the primary liptinite component in this sample (55.3 vol.%; fig. 2G; listed as “other liptinite” in Table 2). The bituminite groundmass hosts discrete liptodetrinite fragments, sporinite, resinite blebs, and alginite, as well as vitrinite fragments. Cannel facies (sporinite-rich) also are present in this sample. The Santo Tomas coal sample contains some similar sapropelic facies although

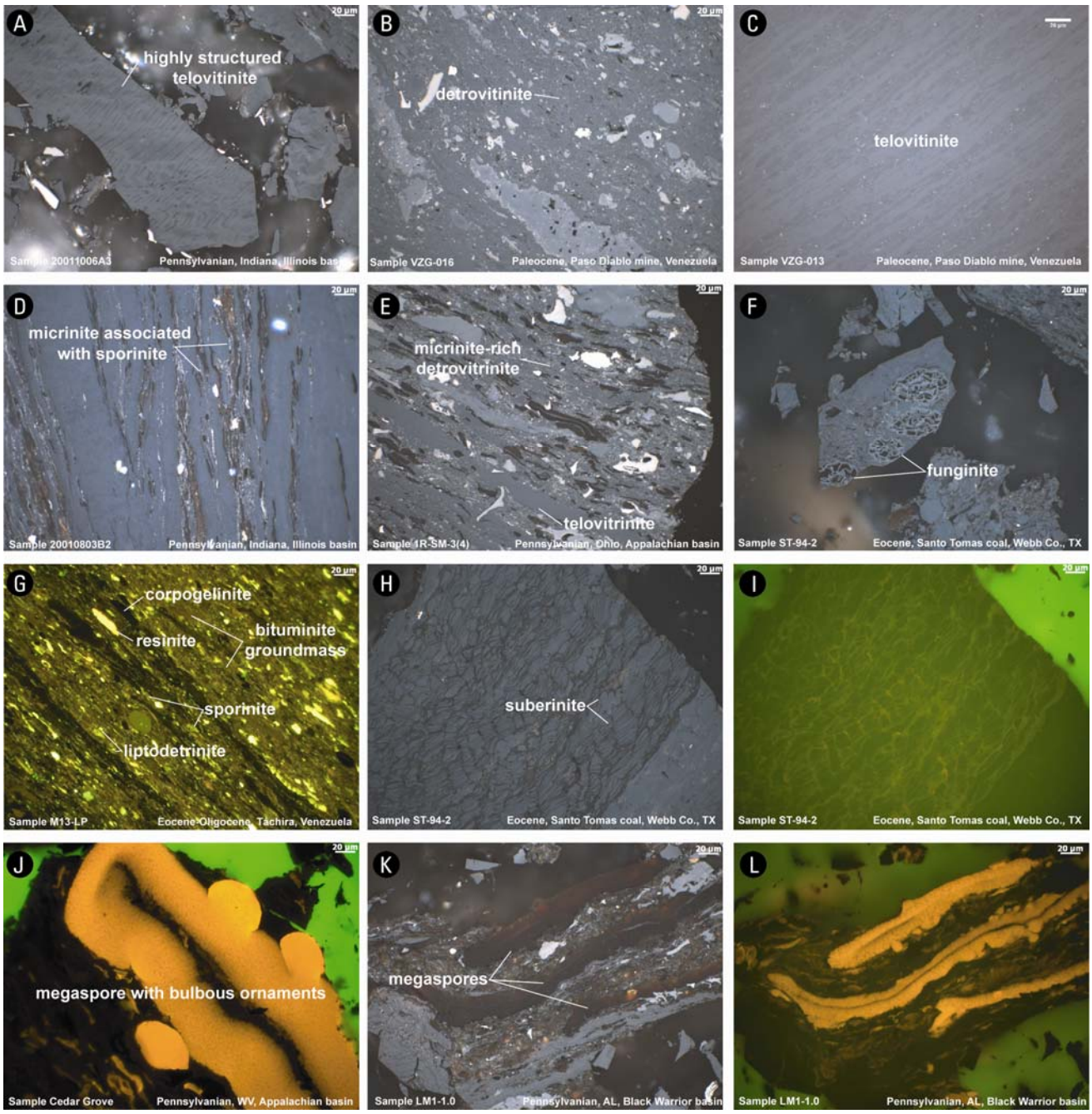


Figure 2. Photomicrographs of high volatile bituminous coal samples. All photomicrographs at 500x magnification under oil immersion except (G) and (J) which were taken with a dry objective. Photomicrographs G, I, J, and L under blue light illumination; all others under white light. (A) Structured telovitrinite illustrating differences in reflectance. Sample 20011006A3, Pennsylvanian, Indiana, Illinois basin. (B) Detrovitrinite hosting inertodetrinite fragments and semifusinite. Sample VZG-016, Paleocene, Marcelina Formation, Paso Diablo mine, Zulia, Venezuela. (C) Telovitrinite. Sample VZG-013, Paleocene, Marcelina Formation, Paso Diablo mine, Zulia, Venezuela. (D) Alternating bands of telovitrinite and micrinite with sporinite. Sample 20010803B2, Pennsylvanian, Indiana, Illinois basin. (E) Micrinite-rich detrovitrinite with fragments of inertodetrinite, semifusinite, fusinite, and sporinite. Sample 1R-SM-3(4), Pennsylvanian, Ohio, Appalachian basin. (F) Funginite. Sample ST-94-2, Eocene, Santo Tomas coal, Claiborne Group, Webb County, Texas. (G) Bituminite groundmass hosting liptodetrinite and vitrinite fragments, sporinite, and resinite. Sample M13-LP, Eocene-Oligocene, Carbonera Formation, La Pajarita mine, Táchira, Venezuela. (H) Suberinite. Sample ST-94-2, Eocene, Santo Tomas coal, Claiborne Group, Webb County, Texas. (I) Same field of view as (H) under blue light. (J) Ornamented megaspore. Sample Cedar Grove, Pennsylvanian, West Virginia, Appalachian basin. (K) Megaspores associated with bands of telovitrinite and mineral matter-rich detrovitrinite. Sample LM1-1.0, Pennsylvanian, Alabama, Black Warrior basin. (L) Same field of view as (K) under blue light.

Sample ID	20010803B2	ST-94-2	M13-LP	20011006A3	VZG-013	1R-SM-3(4)	VZG-016	LM1-1.0	Cedar Grove
telovitrinite	75.9	48.1	14.3	77.8	36.8	42.4	21.9	70.8	59.5
detrovitrinite	2.3	21.8	14.1	6.0	41.2	21.5	46.9	9.3	8.3
total vitrinite	78.2	69.9	28.4	83.8	78.0	63.9	68.8	80.1	67.8
fusinite	X	X	X	2.3	3.9	2.6	4.6	2.2	5.0
semifusinite	X	0.7	X	1.8	11.0	6.3	16.0	3.4	11.5
macrinite	X	0.3	X	X	X	X	X	X	0.3
funginite	X	0.9	0.5	X	0.2	X	X	X	X
secretinite	X	X	X	X	X	0.1	X	X	X
micrinite	7.3	X	X	2.0	0.6	10.7	1.3	1.0	6.1
inertodetrinite	0.1	X	0.4	0.9	2.8	2.3	6.2	0.3	1.1
total inertinite	7.4	1.9	0.9	7.0	18.5	22.0	28.1	6.9	24.0
sporinite	6.3	2.3	2.9	3.8	0.3	6.6	0.2	3.8	5.0
cutinite	2.8	0.5	X	0.6	0.4	0.6	0.2	0.1	0.4
resinite	1.9	1.8	1.0	0.1	1.3	0.4	0.3	0.3	0.3
suberinite	X	0.8	X	X	X	X	X	X	X
alginite	X	0.3	1.3	X	X	X	X	X	X
liptodetrinite	X	7.8	5.8	X	0.1	X	0.1	X	X
other liptinite	X	4.8	55.3	X	X	X	X	X	X
total liptinite	11.0	18.3	66.3	4.5	2.1	7.6	0.8	4.2	5.7
p.c. mineral	3.4	9.9	4.4	4.7	1.4	6.5	2.3	8.8	2.5
calc. mineral	2.5	5.9	2.1	3.6	0.6	3.2	1.2	8.6	2.4

X = not present or present in amounts <0.1 vol.%; p.c. = point count; calc. = calculated (ASTM, 2007).

Table 2. Petrographic data on volume percent whole coal basis.

total liptinite content in this sample is much lower at 18.3 vol.%, including 4.8 vol.% bituminite groundmass. Suberinite also is present in small quantities in this sample (fig. 2H-I). The humic coal samples contain 0.8-11.0 vol.% liptinite generally dominated by sporinite. In particular, the Cedar Grove and Black Warrior basin coals contain megaspores with bulbous ornamental appendages (fig. 2J-L). Where detached, these would be indistinguishable from ovoid resinite blebs.

Several of the samples included in this study (ST-94-2, 20010803B2, and 20011006A3) previously were analyzed for petrographic composition by other laboratories. To exclude the potential for interlaboratory variation, these samples were reanalyzed for this study at the same time as the new samples. For these three samples, a comparison with the earlier results is presented in Table 3. Relatively good agreement is indicated between laboratories for the three maceral groups and mineral matter.

Acknowledgements

Reviews by Peter Warwick and MaryAnn Malinconico of USGS improved this report.

The authors thank the following individuals for collecting the samples used in this study: Eligio González (INGEOMIN) (sample M13-LP); VZG-013 and VZG-016 by Manuel Martínez (Universidad Central de Venezuela); ST-94-2 by Peter Warwick (USGS); 20010803B2 and 20011006A3 by Maria Mastalerz (Indiana Geological Survey); LM1-1.0 by Richard Carroll (Alabama Geological Survey), Cedar Grove by Harold Gluskoter (USGS), and 1R-SM-3(4) by Jon Kolak, Leslie Ruppert (USGS) and Nick Fedorko (West Virginia Geological Survey).

		Volume% Whole Coal			
Sample ID	Source	%Vit	%Inert	%Lip	%Min*
20010803B2	Mastalerz and others (2004)	82.6	1.2	14.0	2.2
	This study	78.2	7.4	11.0	3.4
ST-94-2	Warwick and Hook (1995)	74.0	tr	26.0	n.r.
	This study	69.9	1.9	18.3	9.9
20011006A3	Mastalerz and others (2004)	91.0	4.4	4.4	0.2
	This study	83.8	7.0	4.5	4.7

*determined from mineral-inclusive point count.

Table 3. Comparison of data from previous petrographic analyses with this study.

References

ASTM, 2007, Annual book of ASTM standards: Petroleum products, lubricants, and fossil fuels; Gaseous fuels; coal and coke, sec. 5, v. 5.06: ASTM International, West Conshohocken, PA, 711 p.

Hackley, P.C., and Martínez, M., 2007, Organic petrology of Paleocene Marcelina Formation coals, Paso Diablo mine, western Venezuela: tectonic controls on coal type: International Journal of Coal Geology, v. 71, n. 4, p. 505-526.

Hackley, P.C., Warwick, P.D., and González, E., 2005, Petrology, mineralogy and geochemistry of mined coals, western Venezuela: International Journal of Coal Geology, v. 63, n. 1-2, p. 68-97.

ICCP, 1998, The new vitrinite classification (ICCP System 1994): Fuel, v. 77, p. 349-358.

ICCP, 2001, The new inertinite classification (ICCP System 1994): Fuel v. 80, p. 459-471.

Kalaitzidis, S., Karapanagioti, H.K., Christanis, K., Bouzinos, A., and Iliopoulou, E., 2006, Evalution of peat and lignite phenanthrene sorption properties in relation to coal petrography: The impact of inertinite. International Journal of Coal Geology, v. 68, n. 1-2, p. 30-38.

Karacan, C.O., and Mitchell, G.D., 2003, Behavior and effect of different coal microlithotypes during gas transport for carbon dioxide sequestration into coal seams. International Journal of Coal Geology, v. 53, n. 4, p. 201-217.

Kolak, J.J., and Burruss, R. C., 2006, Geochemical investigation of the potential for mobilizing non-methane hydrocarbons during carbon dioxide storage in deep coal beds: Energy and Fuels, v. 20, n. 2, p. 566-574.

Mastalerz, M., Gluskoter, H., and Rupp, J., 2004, Carbon dioxide and methane sorption in high volatile bituminous coals from Indiana, USA: International Journal of Coal Geology, v. 60, n. 1, p. 43-55.

Petersen, H.I., and Rosenberg, P., 2000, The relationship between the composition and rank of humic coals and their activation energy distributions for the generation of bulk petroleum: Petroleum Geoscience, v. 6, no. 2, p. 137-149.

Sýkorová, I., Pickel, W., Christanis, K., Wolf, M., Taylor, G.H., and Flores, D., 2005, Classification of huminite-ICCP System 1994: International Journal of Coal Geology, v. 62, n. 1-2, p. 85-106.

Taylor, G.H., Teichmüller, Davis, A., Diessel, C.F.K., Littke, R., and Robert, P., 1998, Organic Petrology: Gerbrüder Borntraeger, Berlin, 704 p.

Warwick, P.D., and Hook, R.W., 1995, Petrography, geochemistry, and depositional setting of the San Pedro and Santo Tomas coal zones: anomalous algae-rich coals in the middle part of the Claiborne Group (Eocene) of Webb County, Texas: International Journal of Coal Geology, v. 28, n. 2-4, p. 303-342.

APPENDIX

Random Reflectance of Vitrinite Reports
Maximum Reflectance of Vitrinite Reports
Organic Composition Reports

Vitrinite Reflectance

Random Reflectance Data

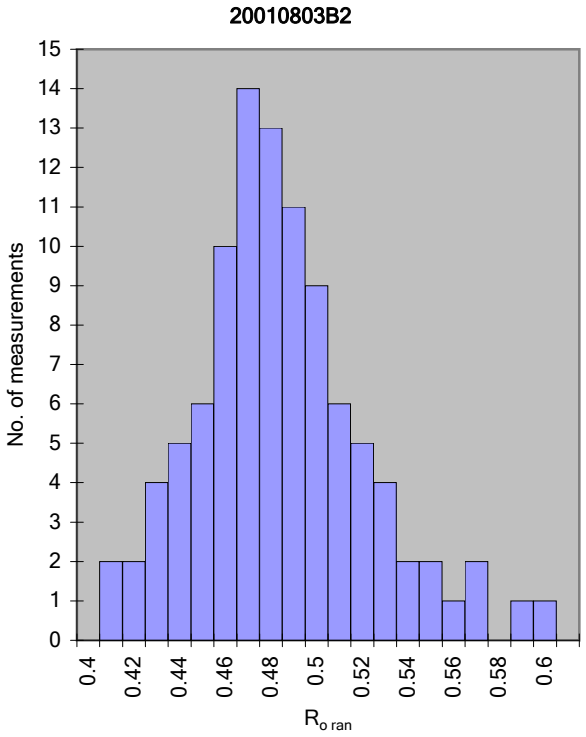
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	20010803B2
Lab ID	145
Sample Type	no data
Date Analyzed:	12/6/2004
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	huminite
$R_{o\ ran}$ (ISO/ASTM):	0.48
s.d.:	0.04



DATA

0.513	0.498	0.486	0.479	0.454	0.459	0.429	0.470	0.496	0.510
0.486	0.464	0.448	0.464	0.402	0.503	0.411	0.522	0.517	0.542
0.491	0.463	0.484	0.467	0.479	0.483	0.457	0.474	0.517	0.529
0.500	0.479	0.516	0.472	0.452	0.464	0.411	0.429	0.514	0.568
0.471	0.535	0.528	0.460	0.459	0.444	0.485	0.441	0.505	0.545
0.493	0.430	0.475	0.473	0.468	0.466	0.562	0.434	0.473	0.468
0.487	0.437	0.485	0.476	0.500	0.402	0.484	0.502	0.491	0.524
0.469	0.443	0.436	0.468	0.487	0.488	0.422	0.532	0.453	0.599
0.457	0.469	0.500	0.462	0.435	0.443	0.551	0.445	0.479	0.581
0.474	0.486	0.455	0.459	0.495	0.467	0.434	0.510	0.502	0.472

min: 0.402 **max:** 0.599 **V-types:** 2

COMMENT

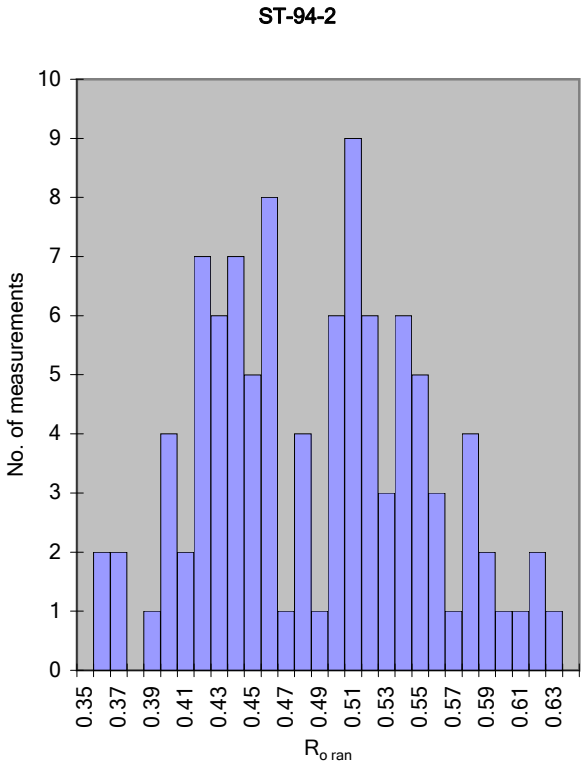
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	ST-94-2
Lab ID	140
Sample Type	no data
Date Analyzed:	1/29/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	huminite
$R_{o\ ran}$ (ISO/ASTM):	0.48
s.d.:	0.06



DATA

0.411	0.367	0.511	0.420	0.437	0.464	0.403	0.553	0.441	0.511
0.439	0.440	0.508	0.474	0.555	0.534	0.453	0.428	0.506	0.451
0.544	0.492	0.503	0.549	0.399	0.491	0.614	0.509	0.355	0.353
0.475	0.530	0.471	0.557	0.519	0.457	0.578	0.593	0.504	0.522
0.390	0.509	0.533	0.451	0.581	0.492	0.412	0.537	0.514	0.542
0.512	0.522	0.486	0.435	0.509	0.499	0.455	0.541	0.508	0.578
0.395	0.527	0.453	0.419	0.480	0.535	0.441	0.562	0.536	0.579
0.605	0.451	0.417	0.588	0.507	0.385	0.458	0.405	0.425	0.414
0.630	0.545	0.576	0.435	0.519	0.445	0.424	0.426	0.442	0.369
0.614	0.432	0.421	0.422	0.494	0.430	0.500	0.438	0.393	0.416

min: 0.353 **max:** 0.630 **V-types:** 4

COMMENT

Highly structured vitrinite. High standard deviation. Rmax for this sample is 0.55%.

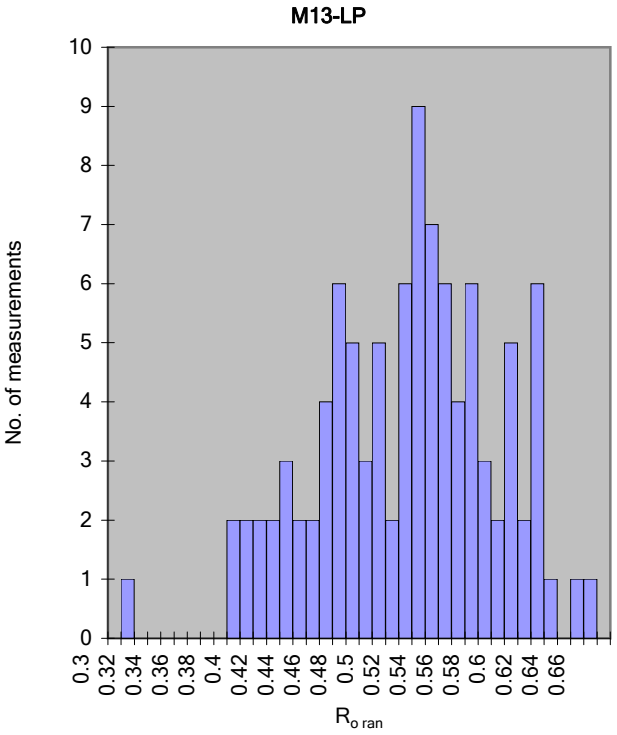
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	E. Gonzalez
Date Submitted:	1/1/2002
Project:	Kolak
Sample:	**M13-LP**
Lab ID	624
Sample Type	channel
Date Analyzed:	1/29/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.52
s.d.:	0.07



DATA

0.483	0.621	0.593	0.524	0.536	0.599	0.527	0.399	0.547	0.535
0.521	0.309	0.490	0.610	0.524	0.495	0.538	0.473	0.495	0.455
0.520	0.451	0.509	0.605	0.523	0.443	0.565	0.539	0.616	0.558
0.656	0.615	0.534	0.528	0.503	0.554	0.615	0.465	0.551	0.464
0.572	0.493	0.566	0.476	0.478	0.467	0.608	0.409	0.433	0.515
0.570	0.600	0.517	0.565	0.550	0.476	0.525	0.589	0.437	0.380
0.544	0.420	0.581	0.420	0.426	0.457	0.527	0.465	0.541	0.482
0.495	0.396	0.650	0.388	0.553	0.530	0.611	0.567	0.415	0.469
0.574	0.421	0.518	0.511	0.545	0.465	0.406	0.456	0.516	0.539
0.546	0.488	0.479	0.539	0.595	0.568	0.448	0.620	0.573	0.600

min: 0.309 **max:** 0.656 **V-types:** 4

COMMENT

Contains highly structured vitrinite with abundant liptinite (bituminite is approximately 50 vol.% of sample). Rmax would be meaningless for this sample due to high degree of structure and presumed lack of bireflectance. Note high standard deviation due to highly structured vitrinite (bitumen impregnation also possible). Sapropelic facies (cannel coal).

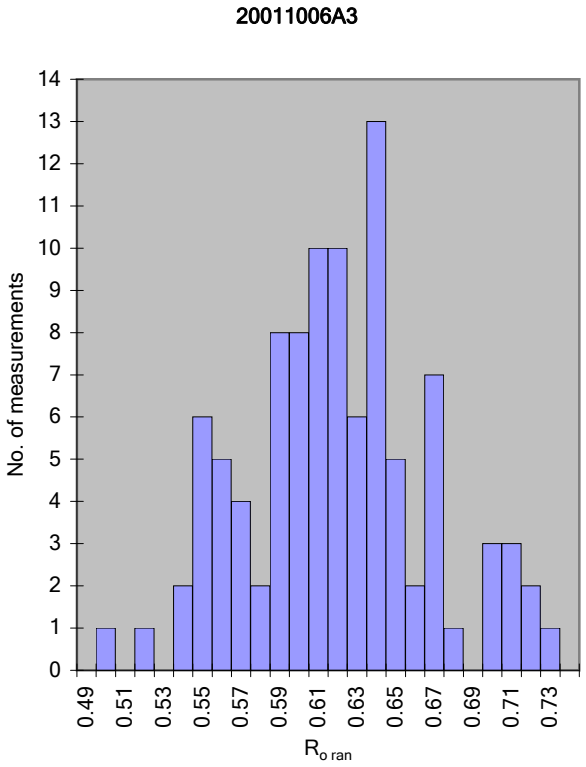
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	20011006A3
Lab ID	142
Sample Type	no data
Date Analyzed:	10/20/2004
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.61
s.d.:	0.05



DATA

0.599	0.547	0.595	0.632	0.589	0.633	0.637	0.604	0.599	0.639
0.599	0.704	0.633	0.605	0.531	0.702	0.691	0.604	0.556	0.652
0.599	0.727	0.542	0.614	0.598	0.552	0.540	0.498	0.618	0.661
0.632	0.585	0.542	0.662	0.620	0.622	0.645	0.622	0.582	0.553
0.697	0.636	0.603	0.614	0.656	0.602	0.620	0.550	0.612	0.580
0.705	0.634	0.606	0.676	0.645	0.621	0.666	0.663	0.586	0.569
0.698	0.606	0.582	0.543	0.618	0.595	0.604	0.670	0.646	0.615
0.630	0.718	0.587	0.514	0.608	0.576	0.619	0.716	0.583	0.570
0.636	0.631	0.594	0.643	0.553	0.634	0.634	0.605	0.558	0.632
0.630	0.615	0.542	0.664	0.663	0.569	0.569	0.647	0.590	0.625

min: 0.498 **max:** 0.727 **V-types:** 4

COMMENT

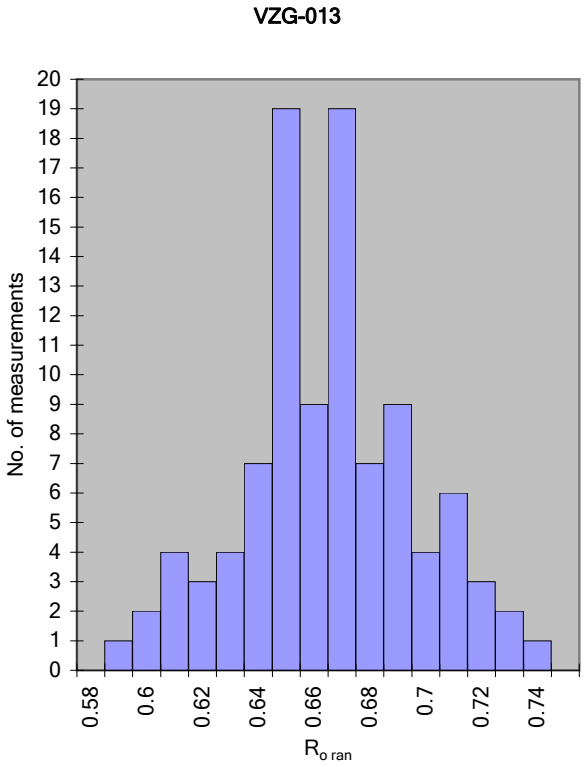
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	M. Martinez
Date Submitted:	no data
Project:	Kolak
Sample:	VZG-013
Lab ID	460
Sample Type	channel
Date Analyzed:	1/29/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.66
s.d.:	0.03



DATA

0.670	0.644	0.652	0.662	0.631	0.670	0.643	0.657	0.667	0.641
0.637	0.658	0.666	0.608	0.671	0.644	0.682	0.616	0.664	0.601
0.672	0.696	0.693	0.657	0.670	0.655	0.650	0.630	0.706	0.705
0.654	0.587	0.591	0.648	0.679	0.626	0.715	0.682	0.664	0.639
0.637	0.646	0.681	0.648	0.730	0.687	0.646	0.668	0.663	0.679
0.694	0.648	0.679	0.665	0.690	0.665	0.713	0.623	0.641	0.708
0.610	0.721	0.667	0.643	0.671	0.665	0.705	0.657	0.665	0.610
0.683	0.599	0.641	0.642	0.710	0.684	0.686	0.650	0.647	0.629
0.669	0.703	0.683	0.674	0.634	0.662	0.606	0.637	0.653	0.641
0.642	0.610	0.661	0.669	0.642	0.731	0.711	0.640	0.696	0.649

min: 0.587 **max:** 0.731 **V-types:** 3

COMMENT

Rmax for this sample is 0.67%.

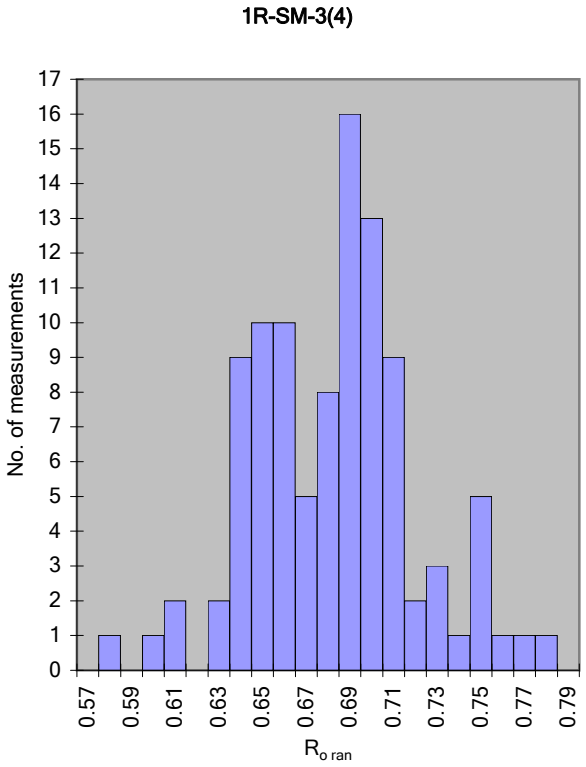
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	1R-SM-3(4)
Lab ID	417
Sample Type	no data
Date Analyzed:	12/6/2004
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.68
s.d.:	0.04



DATA

0.758	0.746	0.698	0.687	0.610	0.661	0.689	0.746	0.707	0.608
0.690	0.747	0.656	0.682	0.637	0.648	0.696	0.662	0.694	0.681
0.657	0.596	0.684	0.717	0.694	0.691	0.643	0.642	0.648	0.652
0.671	0.721	0.686	0.721	0.699	0.631	0.680	0.697	0.685	0.709
0.722	0.698	0.631	0.698	0.659	0.655	0.579	0.709	0.624	0.682
0.667	0.662	0.709	0.705	0.693	0.686	0.633	0.633	0.656	0.713
0.629	0.709	0.750	0.705	0.684	0.686	0.656	0.635	0.640	0.683
0.705	0.707	0.766	0.651	0.673	0.672	0.679	0.676	0.649	0.684
0.648	0.680	0.641	0.746	0.698	0.699	0.683	0.654	0.663	0.738
0.640	0.778	0.682	0.636	0.648	0.659	0.673	0.647	0.642	0.698

min: 0.579 **max:** 0.778 **V-types:** 3

COMMENT

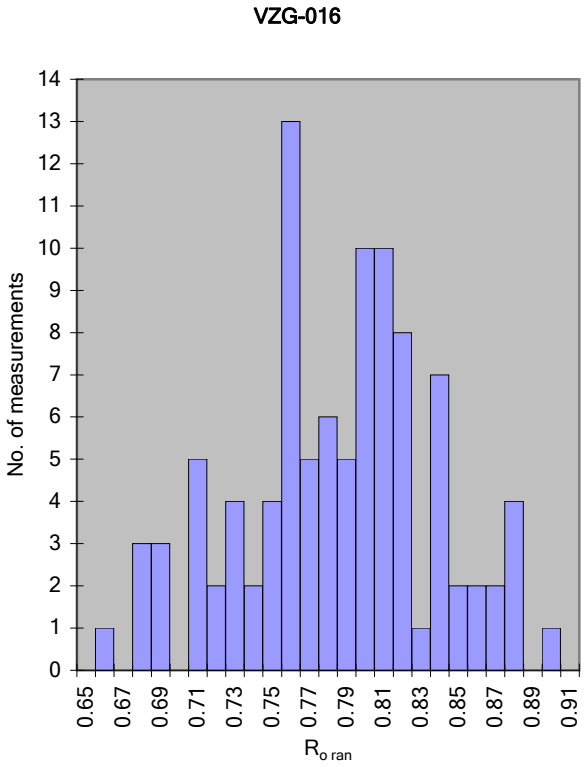
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	M. Martinez
Date Submitted:	no data
Project:	Kolak
Sample:	VZG-016
Lab ID	463
Sample Type	channel
Date Analyzed:	1/29/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.78
s.d.:	0.05



DATA

0.758	0.837	0.797	0.724	0.677	0.705	0.831	0.795	0.756	0.805
0.852	0.803	0.785	0.861	0.723	0.806	0.779	0.790	0.792	0.843
0.767	0.818	0.787	0.719	0.708	0.759	0.738	0.802	0.723	0.708
0.774	0.821	0.813	0.794	0.760	0.748	0.765	0.819	0.717	0.812
0.767	0.800	0.839	0.899	0.752	0.795	0.800	0.812	0.676	0.759
0.746	0.791	0.769	0.707	0.778	0.754	0.879	0.689	0.849	0.819
0.783	0.812	0.838	0.797	0.751	0.805	0.777	0.774	0.748	0.834
0.774	0.815	0.794	0.808	0.673	0.866	0.767	0.789	0.754	0.727
0.708	0.680	0.651	0.876	0.758	0.799	0.809	0.875	0.737	0.758
0.741	0.759	0.686	0.803	0.876	0.832	0.759	0.808	0.858	0.838

min: 0.651 **max:** 0.899 **V-types:** 3

COMMENT

Rmax also 0.78%. Higher rank than all other Paso Diablo samples. See Hackley and Martínez, 2007.

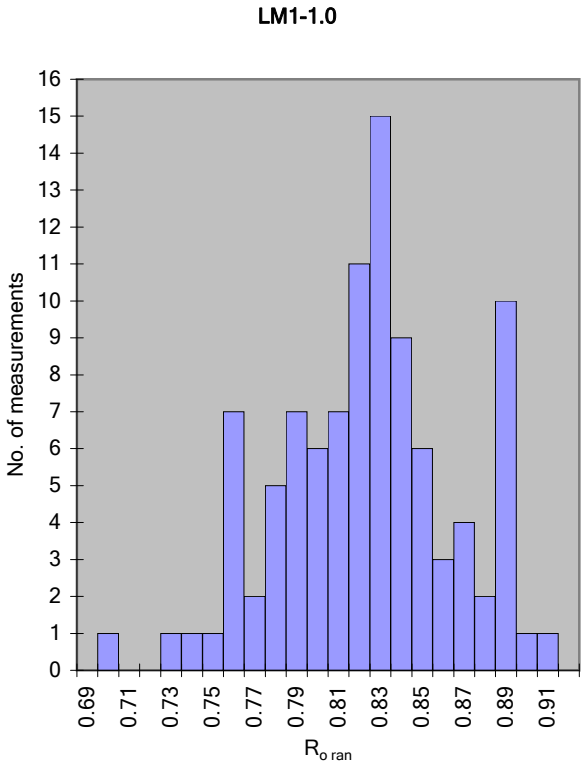
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	**LM1-1.0**
Lab ID	141
Sample Type	no data
Date Analyzed:	1/29/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.82
s.d.:	0.04



DATA

0.829	0.786	0.824	0.783	0.841	0.820	0.846	0.835	0.845	0.796
0.732	0.751	0.802	0.822	0.801	0.802	0.882	0.818	0.819	0.886
0.851	0.791	0.844	0.821	0.792	0.834	0.753	0.886	0.755	0.884
0.784	0.795	0.882	0.834	0.867	0.799	0.816	0.771	0.754	0.846
0.842	0.804	0.763	0.883	0.773	0.824	0.775	0.728	0.812	0.835
0.789	0.785	0.760	0.831	0.865	0.772	0.824	0.817	0.889	0.818
0.763	0.747	0.828	0.694	0.835	0.772	0.832	0.796	0.814	0.840
0.896	0.876	0.859	0.801	0.781	0.811	0.819	0.852	0.906	0.867
0.829	0.784	0.826	0.826	0.874	0.828	0.881	0.807	0.812	0.759
0.826	0.862	0.751	0.881	0.825	0.823	0.834	0.829	0.810	0.882

min: 0.694 **max:** 0.906 **V-types:** 4

COMMENT

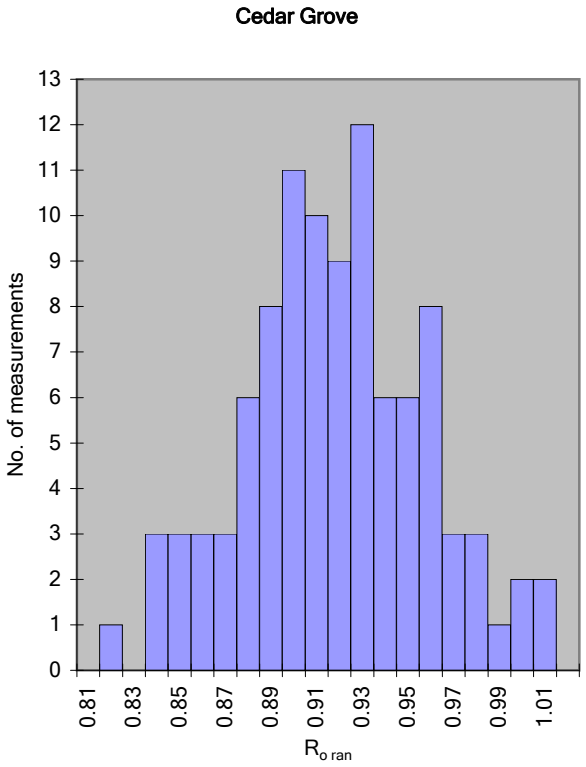
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	Cedar Grove
Lab ID	143
Sample Type	no data
Date Analyzed:	12/15/2004
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	vitrinite
$R_{o\ ran}$ (ISO/ASTM):	0.91
s.d.:	0.04



DATA

0.901	0.929	0.893	0.893	0.919	0.914	0.898	0.882	0.833	0.844
0.959	0.961	0.858	0.911	0.950	0.956	0.904	0.884	0.924	0.907
0.864	0.902	1.007	0.940	0.858	0.974	0.928	0.950	0.937	0.919
0.959	0.967	0.894	0.885	0.855	0.895	0.977	0.925	0.842	0.950
0.928	0.892	0.978	0.925	0.925	0.899	0.897	0.902	0.916	0.874
0.914	0.945	0.953	0.874	0.893	0.912	0.936	0.956	0.816	0.862
0.890	0.954	0.888	0.887	1.003	0.910	0.999	0.905	0.911	0.839
0.945	0.901	0.914	0.874	0.936	0.908	0.871	0.841	0.940	0.921
0.885	0.898	0.900	0.835	0.877	0.955	0.927	0.922	0.982	0.948
0.963	0.903	0.867	0.951	0.876	0.884	0.927	0.997	0.928	0.938

min: 0.816 **max:** 1.007 **V-types:** 3

COMMENT

Vitrinite Reflectance

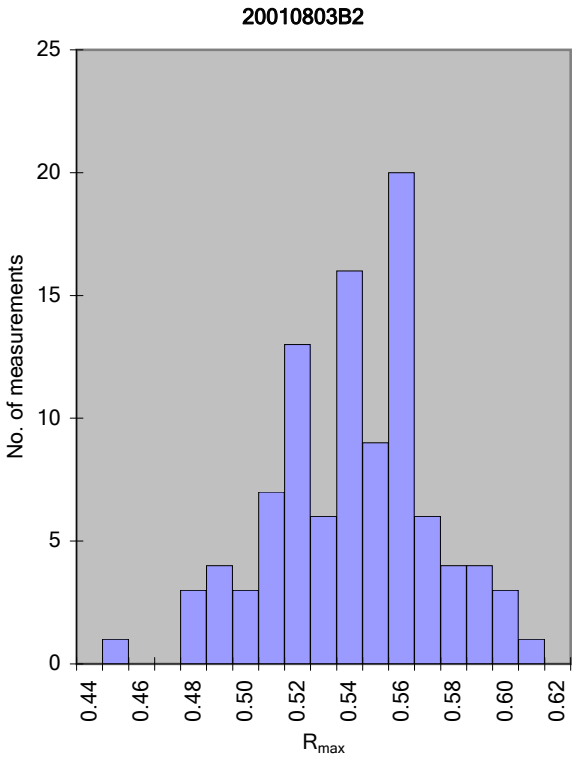
Maximum Reflectance Data

VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by: J. Kolak
9/9/2004
Kolak

20010803B2
145
no data
1/25/2008
P. Hackley



RESULTS

100

0.54
0.03

DATA

0.562	0.546	0.516	0.577	0.545	0.520	0.557	0.537	0.531	0.509
0.502	0.515	0.527	0.585	0.519	0.564	0.553	0.550	0.582	0.561
0.556	0.555	0.572	0.514	0.518	0.538	0.565	0.535	0.498	0.515
0.538	0.536	0.500	0.556	0.448	0.595	0.520	0.529	0.539	0.546
0.533	0.532	0.524	0.552	0.556	0.512	0.553	0.504	0.554	0.566
0.552	0.562	0.520	0.506	0.519	0.553	0.578	0.484	0.538	0.533
0.545	0.588	0.493	0.548	0.594	0.590	0.607	0.550	0.510	0.552
0.509	0.551	0.540	0.474	0.558	0.529	0.574	0.553	0.589	0.529
0.542	0.540	0.474	0.481	0.546	0.535	0.529	0.481	0.480	0.554
0.552	0.558	0.534	0.530	0.490	0.558	0.506	0.520	0.552	0.507

0.448 **max:** 0.607 **V-types:** 3

COMMENT

Vitrinite highly structured. Consistent bireflectance absent. Ro measured 0.48%. Liptinite abundant. Illinois basin coal.

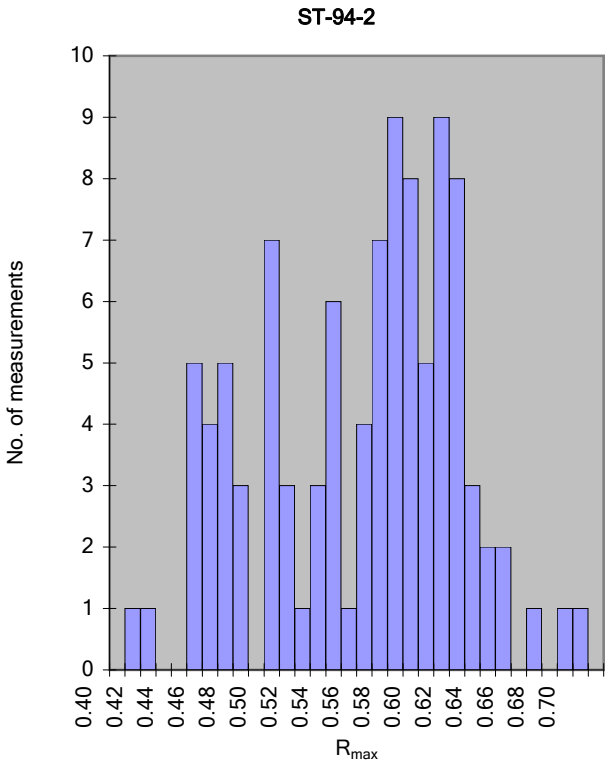
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	**ST-94-2**
Lab ID	**140**
Sample Type	no data
Date Analyzed:	1/25/2008
Operator:	P. Hackley

RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.55
s.d.:	0.06



DATA

0.573	0.574	0.464	0.558	0.554	0.630	0.490	0.570	0.490	0.441
0.571	0.531	0.601	0.625	0.617	0.560	0.451	0.534	0.467	0.503
0.496	0.445	0.517	0.681	0.464	0.609	0.496	0.541	0.601	0.599
0.536	0.453	0.559	0.463	0.592	0.576	0.565	0.454	0.613	0.610
0.502	0.584	0.561	0.589	0.447	0.596	0.525	0.586	0.646	0.610
0.622	0.568	0.606	0.530	0.473	0.610	0.615	0.601	0.529	0.639
0.617	0.569	0.613	0.474	0.613	0.590	0.523	0.574	0.412	0.589
0.576	0.466	0.479	0.563	0.494	0.573	0.616	0.457	0.590	0.569
0.661	0.605	0.640	0.450	0.607	0.586	0.577	0.581	0.645	0.590
0.533	0.599	0.558	0.497	0.501	0.533	0.408	0.694	0.446	0.490

min: 0.408 **max:** 0.694 **V-types:** 3

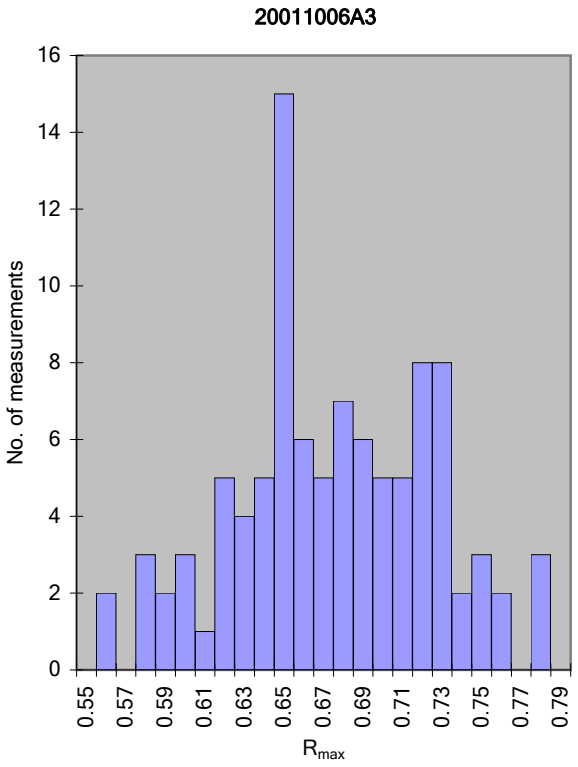
COMMENT

Vitrinite does not display bireflectance. Vitrinite highly structured and Rmax is more a function of structural variation than bireflectance (note high standard deviation). Ro (0.48 %) probably is a better measure of maturity. Claiborne Santo Tomas coal, Webb County, Texas. See Warwick and Hook, 1995.

VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	**20011006A3**
Lab ID	**142**
Sample Type	no data
Date Analyzed:	1/23/2008
Operator:	P. Hackley



RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.67
s.d.:	0.05

DATA

0.672	0.708	0.590	0.614	0.656	0.778	0.679	0.692	0.680	0.725
0.705	0.655	0.576	0.773	0.577	0.693	0.633	0.673	0.640	0.673
0.649	0.700	0.556	0.629	0.608	0.722	0.654	0.628	0.664	0.720
0.650	0.618	0.639	0.592	0.663	0.745	0.652	0.647	0.641	0.644
0.723	0.686	0.735	0.622	0.574	0.690	0.739	0.668	0.673	0.699
0.706	0.693	0.650	0.595	0.588	0.649	0.684	0.649	0.717	0.751
0.776	0.558	0.682	0.637	0.612	0.652	0.639	0.718	0.718	0.717
0.644	0.747	0.636	0.654	0.714	0.713	0.725	0.649	0.629	0.649
0.725	0.673	0.694	0.612	0.663	0.685	0.643	0.715	0.618	0.730
0.721	0.688	0.592	0.662	0.644	0.722	0.756	0.744	0.710	0.640

min: 0.556 **max:** 0.778 **V-types:** 3

COMMENT

Ro measured is 0.61%. Vitrinite is highly structured and not systematically birefringent, i.e., mostly isotropic.

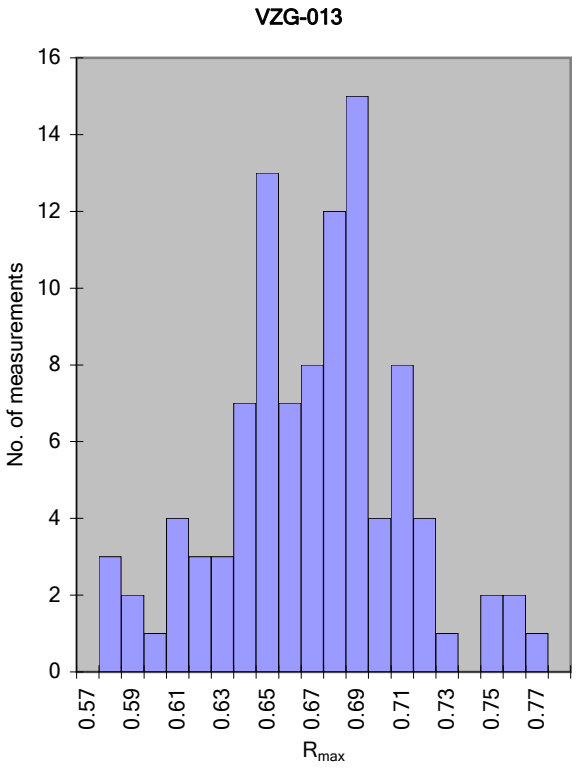
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	M.Martinez
Date Submitted:	1/7/2005
Project:	Paso Diablo
Sample:	VZG-013
Lab ID	460
Sample Type	channel
Date Analyzed:	5/17/2005
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.67
s.d.:	0.04



DATA

0.682	0.684	0.624	0.668	0.603	0.669	0.747	0.713	0.682	0.658
0.587	0.622	0.644	0.604	0.703	0.708	0.716	0.758	0.676	0.688
0.761	0.658	0.613	0.581	0.759	0.672	0.671	0.601	0.647	0.688
0.632	0.652	0.664	0.612	0.680	0.695	0.750	0.649	0.702	0.657
0.671	0.572	0.642	0.717	0.685	0.678	0.691	0.679	0.705	0.682
0.659	0.644	0.632	0.640	0.578	0.670	0.696	0.658	0.676	0.681
0.644	0.681	0.575	0.625	0.724	0.685	0.689	0.670	0.642	0.676
0.681	0.635	0.643	0.609	0.710	0.690	0.667	0.672	0.700	0.717
0.637	0.593	0.637	0.670	0.645	0.638	0.707	0.672	0.667	0.642
0.707	0.649	0.651	0.611	0.646	0.671	0.649	0.701	0.681	0.685

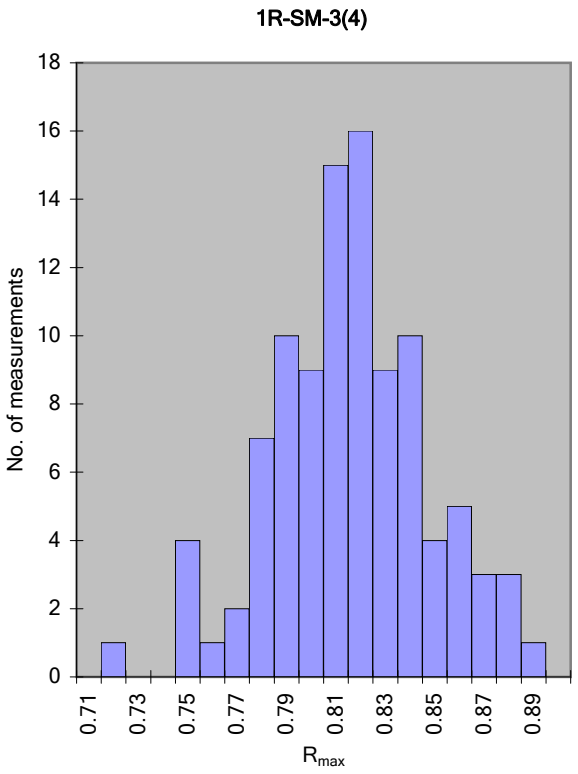
min: 0.572 **max:** 0.761 **V-types:** 3

COMMENT

VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	**1R-SM-3(4)**
Lab ID	**417**
Sample Type	no data
Date Analyzed:	1/28/2008
Operator:	P. Hackley



RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.81
s.d.:	0.03

DATA

0.761	0.818	0.859	0.778	0.815	0.858	0.827	0.820	0.813	0.796
0.800	0.819	0.859	0.786	0.836	0.808	0.829	0.779	0.792	0.802
0.816	0.834	0.779	0.785	0.782	0.846	0.840	0.821	0.779	0.719
0.813	0.812	0.816	0.787	0.771	0.809	0.843	0.801	0.861	0.784
0.804	0.863	0.792	0.825	0.867	0.759	0.779	0.743	0.802	0.810
0.834	0.876	0.814	0.806	0.823	0.749	0.833	0.836	0.827	0.744
0.761	0.806	0.818	0.818	0.790	0.744	0.794	0.836	0.786	0.804
0.784	0.836	0.777	0.855	0.812	0.875	0.841	0.787	0.871	0.801
0.803	0.826	0.832	0.827	0.849	0.794	0.809	0.857	0.818	0.797
0.823	0.781	0.806	0.819	0.820	0.794	0.798	0.885	0.835	0.799

min: 0.719 **max:** 0.885 **V-types:** 2

COMMENT

Consistent bireflectance. Tight histogram.

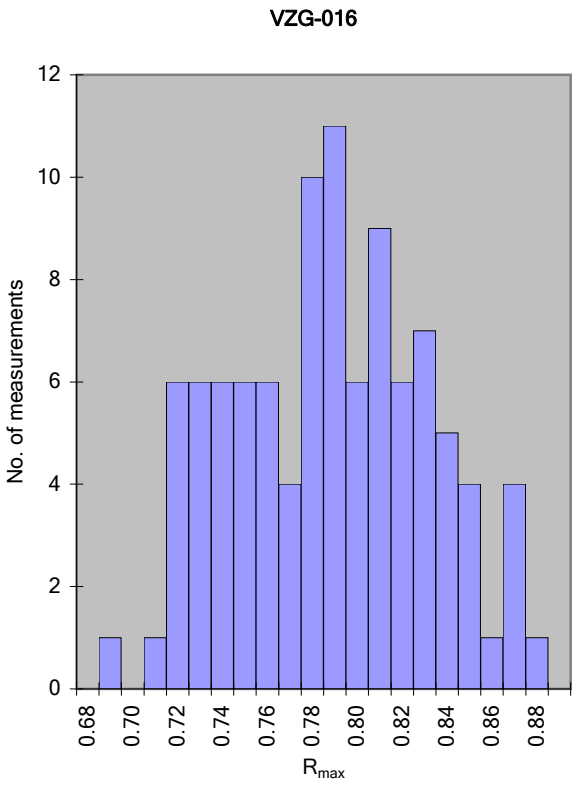
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	M.Martinez
Date Submitted:	1/7/2005
Project:	Paso Diablo
Sample:	VZG-016
Lab ID	463
Sample Type	channel
Date Analyzed:	4/20/2005
Operator:	P.Hackley

RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.78
s.d.:	0.04



DATA

0.804	0.727	0.772	0.749	0.773	0.720	0.730	0.822	0.755	0.713
0.826	0.836	0.753	0.810	0.802	0.748	0.702	0.812	0.713	0.778
0.879	0.781	0.738	0.756	0.729	0.786	0.756	0.809	0.772	0.806
0.841	0.826	0.768	0.791	0.731	0.772	0.789	0.730	0.864	0.716
0.768	0.729	0.803	0.836	0.794	0.755	0.856	0.711	0.870	0.737
0.792	0.813	0.810	0.783	0.787	0.839	0.778	0.777	0.847	0.816
0.720	0.842	0.789	0.814	0.743	0.827	0.788	0.826	0.832	0.759
0.770	0.809	0.797	0.806	0.743	0.776	0.773	0.862	0.866	0.792
0.748	0.796	0.771	0.811	0.737	0.764	0.829	0.733	0.836	0.727
0.745	0.784	0.842	0.828	0.686	0.783	0.781	0.731	0.820	0.782

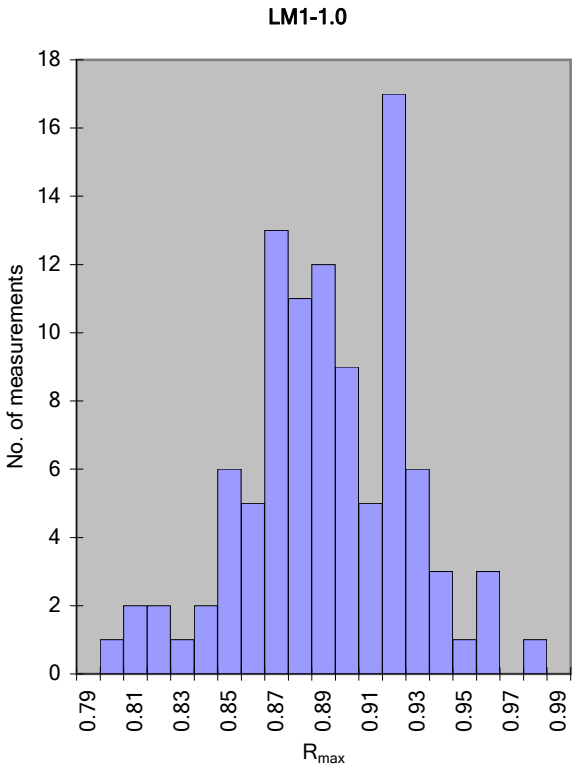
min: 0.686 **max:** 0.879 **V-types:** 3

COMMENT

VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	**LM1-1.0**
Lab ID	**141**
Sample Type	no data
Date Analyzed:	1/23/2008
Operator:	P. Hackley



RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.89
s.d.:	0.03

DATA

0.883	0.877	0.918	0.876	0.957	0.912	0.799	0.896	0.914	0.912
0.871	0.819	0.892	0.920	0.873	0.863	0.930	0.900	0.894	0.860
0.827	0.868	0.917	0.917	0.843	0.889	0.978	0.899	0.956	0.840
0.803	0.879	0.899	0.859	0.849	0.897	0.899	0.846	0.890	0.885
0.850	0.871	0.919	0.816	0.837	0.860	0.863	0.910	0.927	0.911
0.869	0.862	0.934	0.882	0.885	0.844	0.867	0.889	0.809	0.864
0.915	0.929	0.878	0.843	0.886	0.931	0.910	0.929	0.878	0.950
0.900	0.877	0.905	0.881	0.923	0.858	0.896	0.866	0.855	0.915
0.908	0.864	0.931	0.918	0.929	0.915	0.869	0.884	0.861	0.918
0.854	0.903	0.952	0.910	0.874	0.869	0.913	0.887	0.887	0.878

min: 0.799 **max:** 0.978 **V-types:** 3

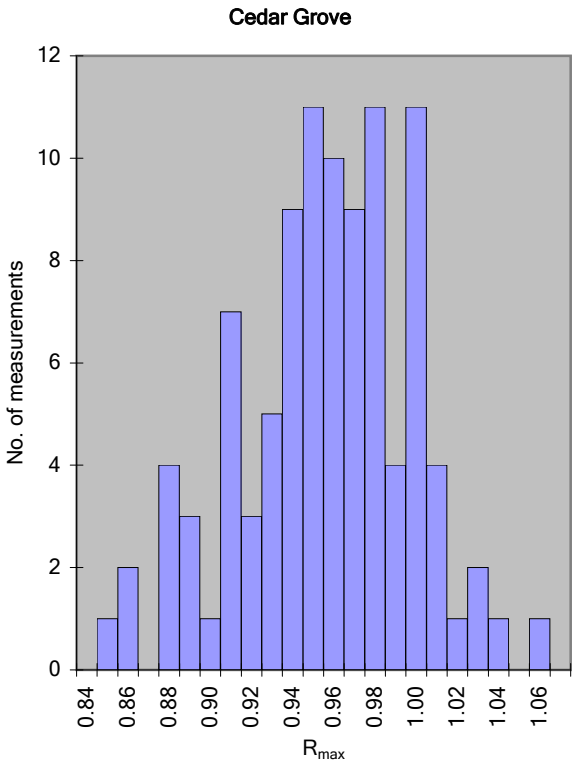
COMMENT

Consistent bireflectance. Tight histogram. Black Warrior basin coal.

VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	**Cedar Grove**
Lab ID	**143**
Sample Type	no data
Date Analyzed:	1/23/2008
Operator:	P. Hackley



RESULTS

# measurements:	100
maceral type:	telovitrinite
R_{max}:	0.95
s.d.:	0.04

DATA

1.011	0.910	0.996	0.969	0.872	0.888	1.009	0.934	0.972	0.936
0.941	0.987	0.996	0.941	0.920	0.935	0.932	0.948	0.992	0.873
1.039	0.903	0.995	0.970	0.975	0.953	0.963	0.874	0.982	0.883
0.988	0.877	1.005	0.989	0.994	0.856	0.973	0.970	0.945	0.970
0.992	0.975	1.026	1.020	0.905	0.904	0.955	0.968	0.976	0.926
0.998	0.947	0.971	1.058	0.976	0.957	0.925	0.962	0.948	0.936
0.958	0.935	0.963	0.942	0.947	0.927	0.907	0.917	0.949	0.905
0.997	0.943	0.972	0.968	0.959	0.843	0.904	0.858	1.001	0.936
0.976	1.004	0.955	0.973	0.895	0.909	0.958	0.966	0.945	0.886
0.957	0.994	0.996	0.954	0.953	0.991	0.934	0.936	0.927	0.914

min: 0.843 **max:** 1.058 **V-types:** 3

COMMENT

All measurements on A pellet; B pellet has poor polish. Ro measured is 0.91%.

Maceral Composition

PETROGRAPHIC ANALYSIS REPORT

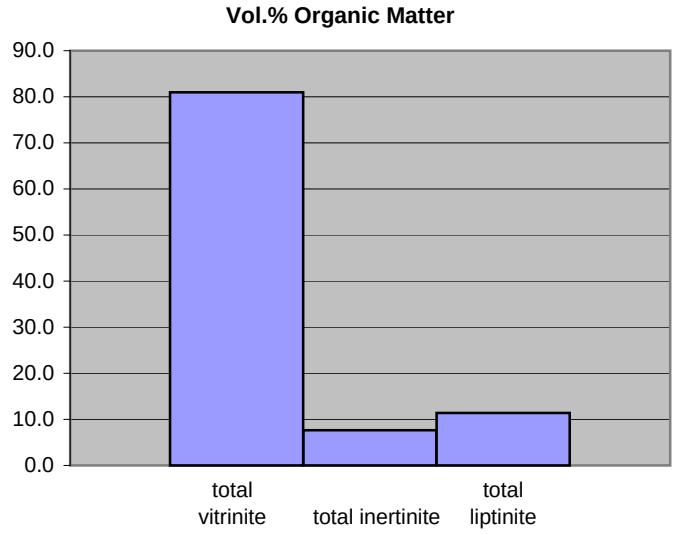
USGS

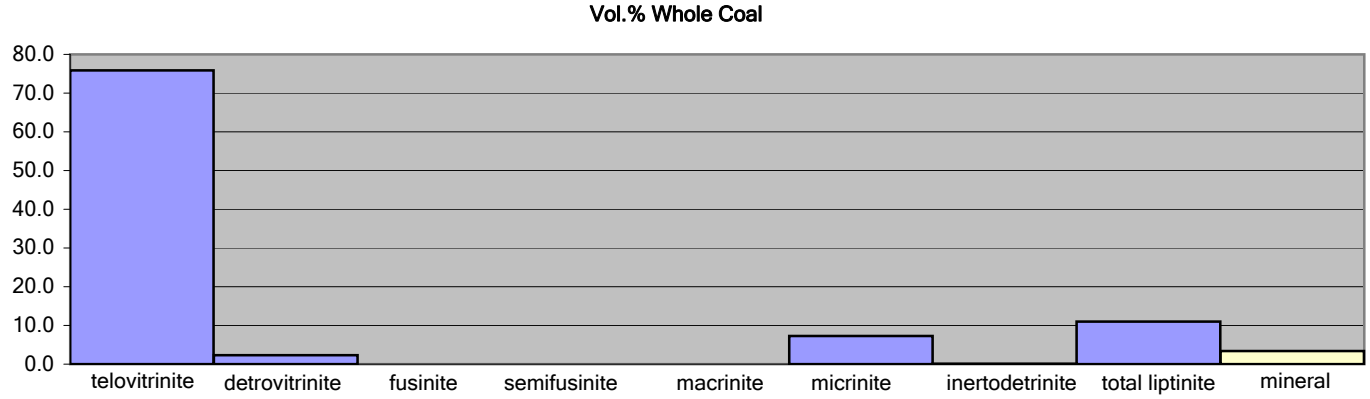
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	20010803B2
Lab ID	145
Sample Type	no data
Date Analyzed:	1/28/2008
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	75.9	78.6
detrovitrinite	2.3	2.4
total vitrinite	78.2	81.0
fusinite	0.0	0.0
semifusinite	0.0	0.0
macrinite	0.0	0.0
funginite	0.0	0.0
secretinite	0.0	0.0
micrinite	7.3	7.6
inertodetrinite	0.1	0.1
total inertinite	7.4	7.7
sporinite	6.3	6.5
cutinite	2.8	2.9
resinite	1.9	2.0
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.0	0.0
other liptinite	0.0	0.0
total liptinite	11.0	11.4
mineral	3.4	
Total	100.0	100.0





COMMENT

Contains 2.53 vol.% mineral matter according to the Parr formula (from extant ash yield and sulfur content data).

PETROGRAPHIC ANALYSIS REPORT

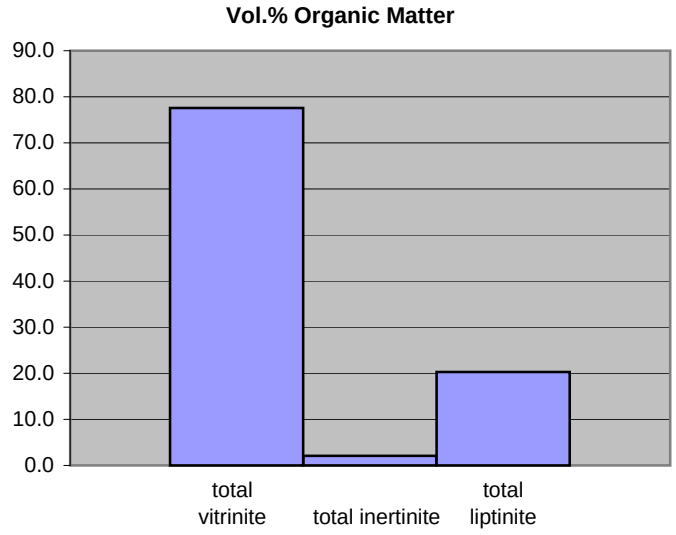
USGS

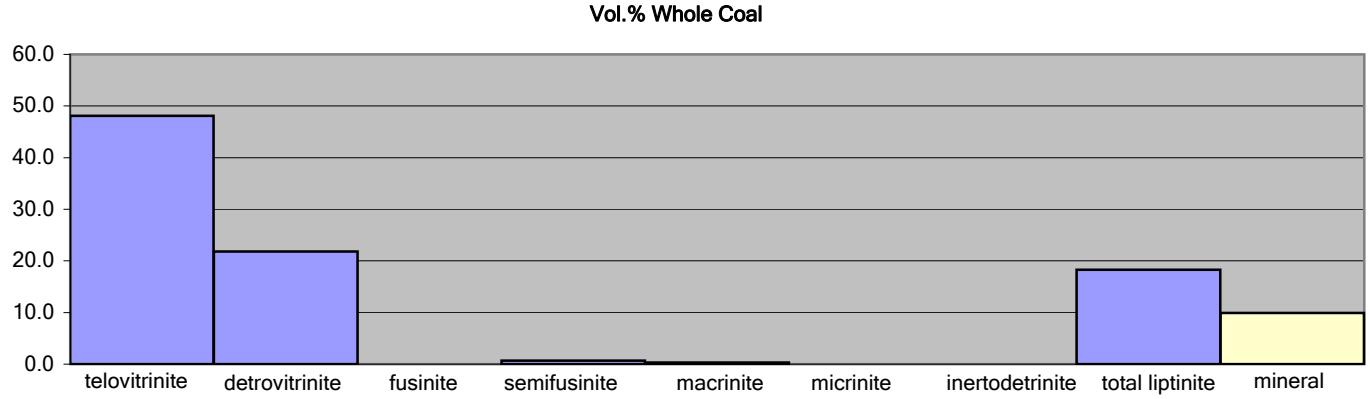
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	ST-94-2
Lab ID	140
Sample Type	channel
Date Analyzed:	1/30/2008
Operator:	P. Hackley
#counts	2000
Rank:	high vol. bituminous

RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	48.1	53.4
detrovitrinite	21.8	24.2
total vitrinite	69.9	77.6
fusinite	0.0	0.0
semifusinite	0.7	0.8
macrinite	0.3	0.3
funginite	0.9	1.0
secretinite	0.0	0.0
micrinite	0.0	0.0
inertodetrinite	0.0	0.0
total inertinite	1.9	2.1
sporinite	2.3	2.6
cutinite	0.5	0.6
resinite	1.8	2.0
suberinite	0.8	0.9
alginite	0.3	0.3
liptodetrinite	7.8	8.6
other liptinite	4.8	5.3
total liptinite	18.3	20.3
mineral	9.9	
Total	100.0	100.0





COMMENT

Quantitative petrographic data also published in Warwick and Hook (1995). Mineral matter calculated from Parr is 5.87 vol.%.

PETROGRAPHIC ANALYSIS REPORT

USGS

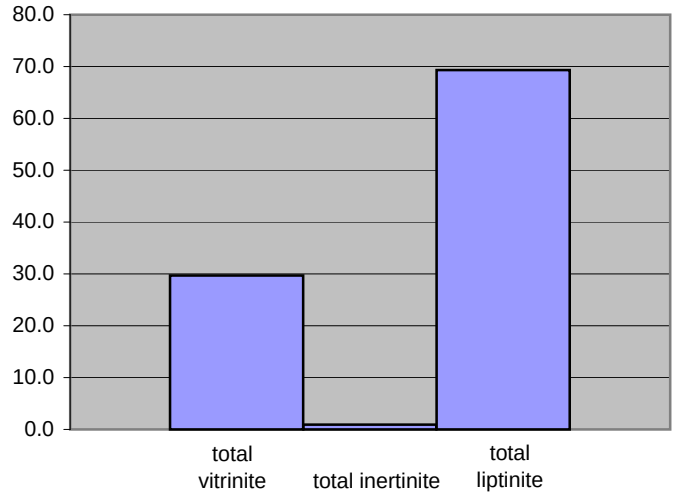
SAMPLE INFORMATION

Submitted by:	M.Martinez
Date Submitted:	1/1/2002
Project:	Venezuela
Sample:	**M13-LP**
Lab ID	624
Sample Type	channel
Date Analyzed:	no data
Operator:	P. Hackley
#counts	2000
Rank:	high vol. bituminous

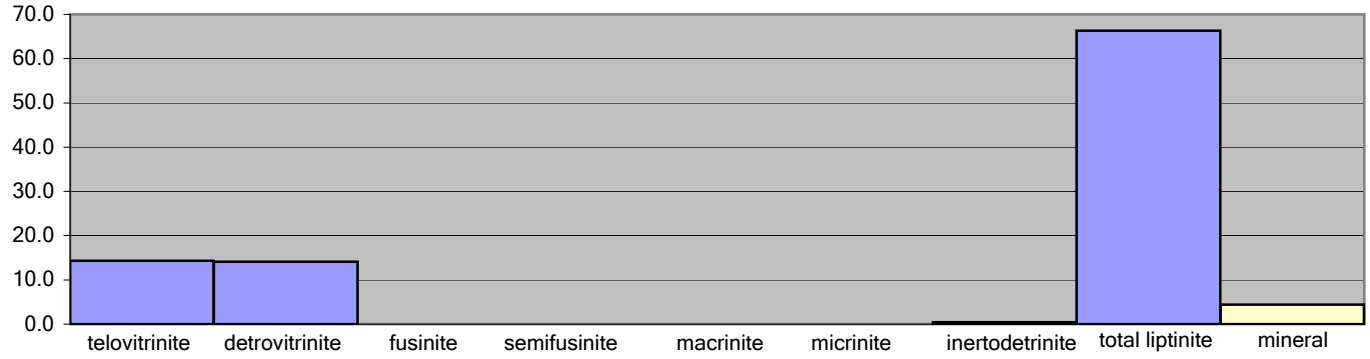
RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	14.3	15.0
detrovitrinite	14.1	14.7
total vitrinite	28.4	29.7
fusinite	0.0	0.0
semifusinite	0.0	0.0
macrinite	0.0	0.0
funginite	0.5	0.5
secretinite	0.0	0.0
micrinite	0.0	0.0
inertodetrinite	0.4	0.4
total inertinite	0.9	0.9
sporinite	2.9	3.0
cutinite	0.0	0.0
resinite	1.0	1.0
suberinite	0.0	0.0
alginite	1.3	1.4
liptodetrinite	5.8	6.1
other liptinite	55.3	57.8
total liptinite	66.3	69.4
mineral	4.4	
Total	100.0	100.0

Vol.% Organic Matter



Vol.% Whole Coal



COMMENT

Other liptinite category is bituminite. Sapropelic coal with some cannel facies (sporinite-rich).

PETROGRAPHIC ANALYSIS REPORT

USGS

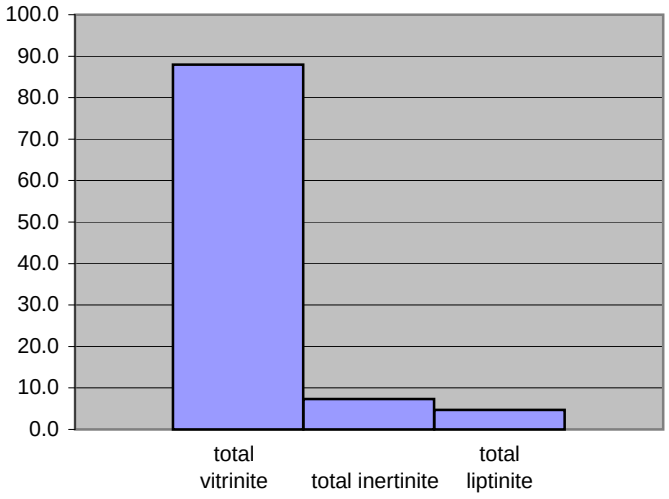
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	20011006A3
Lab ID	142
Sample Type	no data
Date Analyzed:	1/28/2008
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

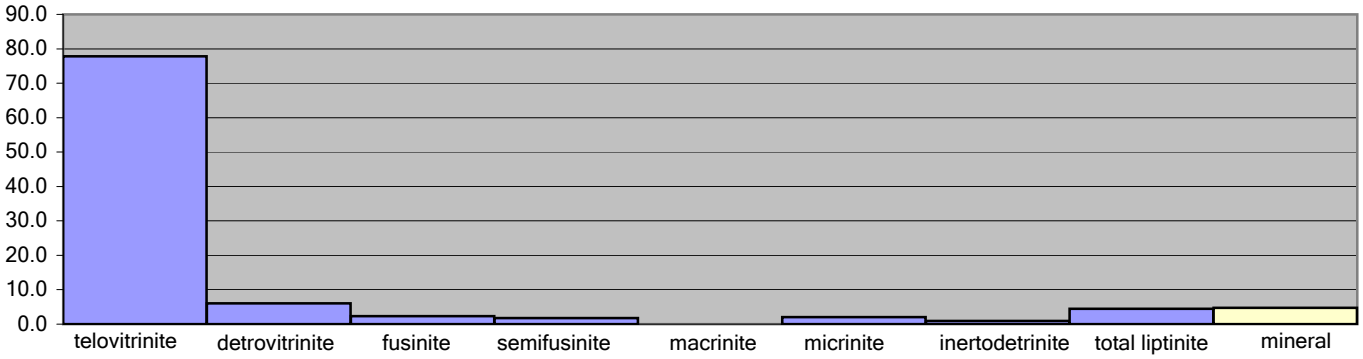
RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	77.8	81.6
detrovitrinite	6.0	6.3
total vitrinite	83.8	87.9
fusinite	2.3	2.4
semifusinite	1.8	1.9
macrinite	0.0	0.0
funginite	0.0	0.0
secretinite	0.0	0.0
micrinite	2.0	2.1
inertodetrinite	0.9	1.0
total inertinite	7.0	7.4
sporinite	3.8	4.0
cutinite	0.6	0.6
resinite	0.1	0.1
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.0	0.0
other liptinite	0.0	0.0
total liptinite	4.5	4.7
mineral	4.7	
Total	100.0	100.0

Vol.% Organic Matter



Vol.% Whole Coal



COMMENT

Contains highly structured vitrinite. Mineral matter according to the Parr formula is 3.58 vol.%.

PETROGRAPHIC ANALYSIS REPORT

USGS

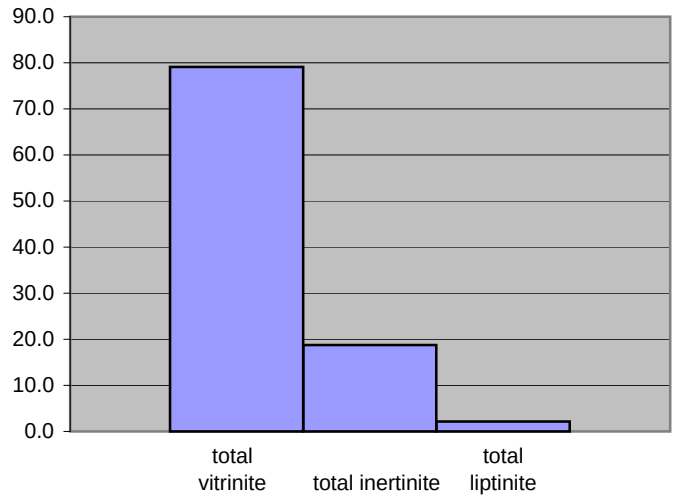
SAMPLE INFORMATION

Submitted by:	M. Martinez
Date Submitted:	1/7/2005
Project:	Paso Diablo
Sample:	VZG-013
Lab ID	460
Sample Type	channel
Date Analyzed:	4/19/2005
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

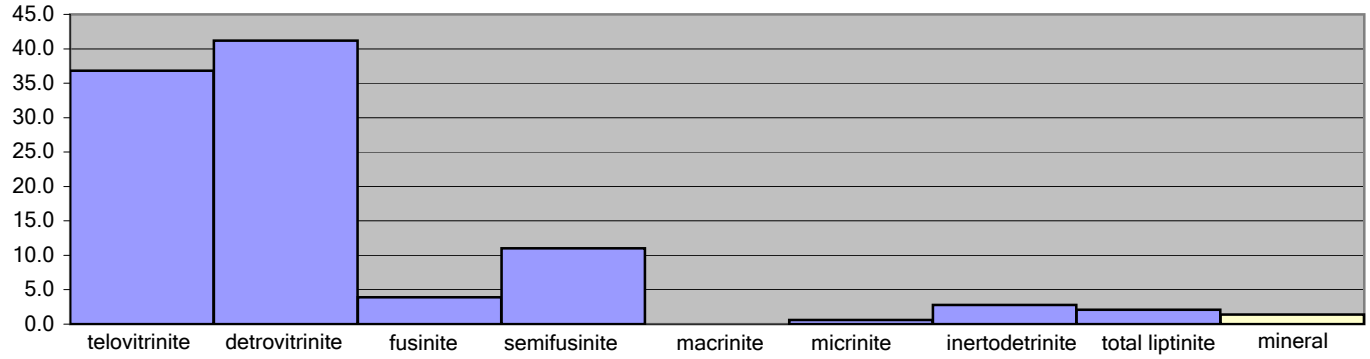
RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	36.8	37.3
detrovitrinite	41.2	41.8
total vitrinite	78.0	79.1
fusinite	3.9	4.0
semifusinite	11.0	11.2
macrinite	0.0	0.0
funginite	0.2	0.2
secretinite	0.0	0.0
micrinite	0.6	0.6
inertodetrinite	2.8	2.8
total inertinite	18.5	18.8
sporinite	0.3	0.3
cutinite	0.4	0.4
resinite	1.3	1.3
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.1	0.1
other liptinite	0.0	0.0
total liptinite	2.1	2.1
mineral	1.4	
Total	100.0	100.0

Vol.% Organic Matter



Vol.% Whole Coal



COMMENT

Initially counted 500 points on B pellet 4/19/2005 (Hackley and Martínez, 2007). 500 points counted on A pellet 1/30/2008 for total of 1000 counts. Counts essentially identical. Macrinite of previous count considered as semifusinite (see also sample VZG-016).

PETROGRAPHIC ANALYSIS REPORT

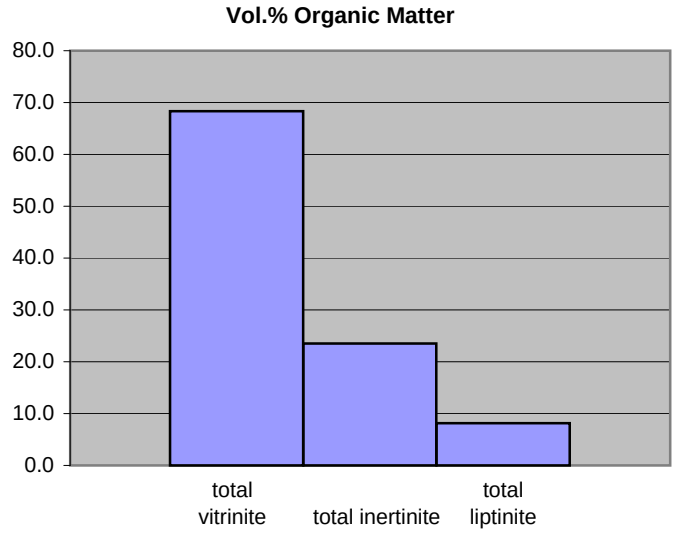
USGS

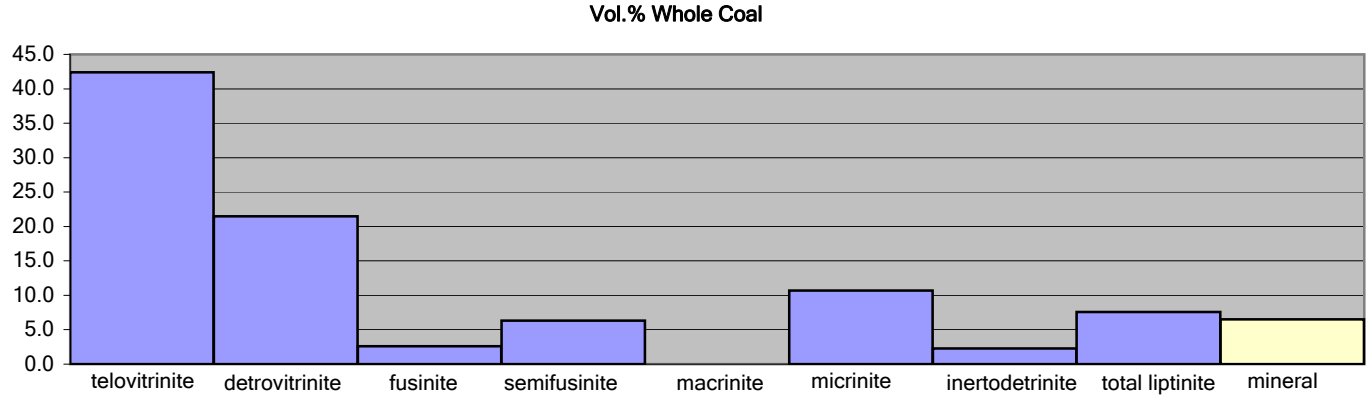
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	1R-SM-3(4)
Lab ID	417
Sample Type	no data
Date Analyzed:	1/29/2008
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	42.4	45.4
detrovitrinite	21.5	23.0
total vitrinite	63.9	68.3
fusinite	2.6	2.8
semifusinite	6.3	6.7
macrinite	0.0	0.0
funginite	0.0	0.0
secretinite	0.1	0.1
micrinite	10.7	11.4
inertodetrinite	2.3	2.5
total inertinite	22.0	23.5
sporinite	6.6	7.1
cutinite	0.6	0.6
resinite	0.4	0.4
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.0	0.0
other liptinite	0.0	0.0
total liptinite	7.6	8.1
mineral	6.5	
Total	100.0	100.0





COMMENT

This sample contains 3.19 vol.% mineral matter according to Parr.

PETROGRAPHIC ANALYSIS REPORT

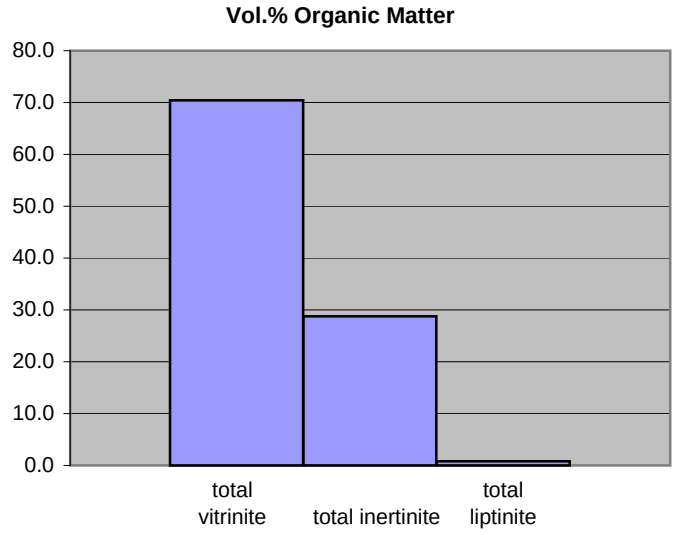
USGS

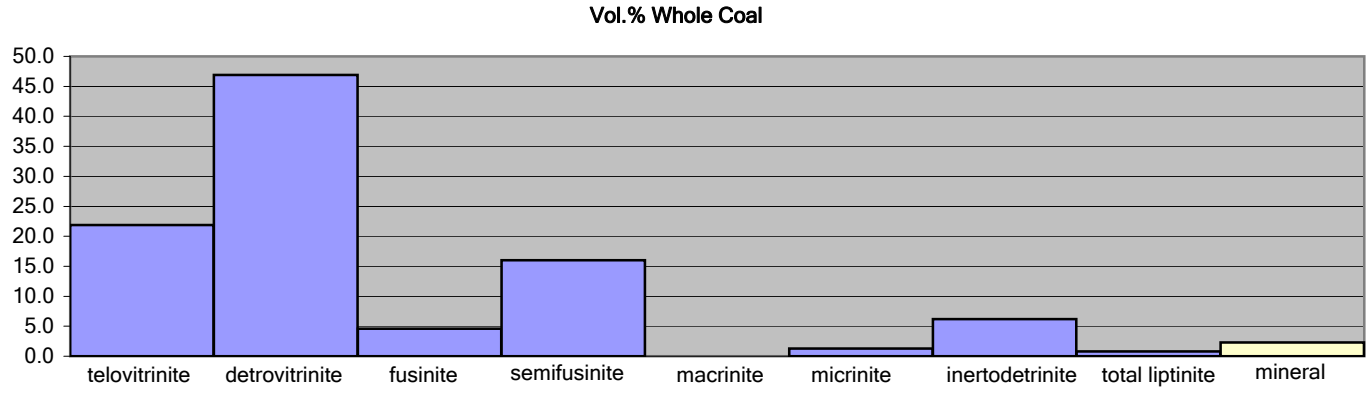
SAMPLE INFORMATION

Submitted by:	M. Martinez
Date Submitted:	1/7/2005
Project:	Paso Diablo
Sample:	VZG-016
Lab ID	463
Sample Type	channel
Date Analyzed:	5/24/2005
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	21.9	22.4
detrovitrinite	46.9	48.0
total vitrinite	68.8	70.4
fusinite	4.6	4.7
semifusinite	16.0	16.4
macrinite	0.0	0.0
funginite	0.0	0.0
secretinite	0.0	0.0
micrinite	1.3	1.3
inertodetrinite	6.2	6.3
total inertinite	28.1	28.8
sporinite	0.2	0.2
cutinite	0.2	0.2
resinite	0.3	0.3
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.1	0.1
other liptinite	0.0	0.0
total liptinite	0.8	0.8
mineral	2.3	
Total	100.0	100.0





COMMENT

Previously analysed (500 counts, A briquette, Hackley and Martínez, 2007). B briquette analyzed on 1/3/08 for a total of 1000 counts. Counts nearly identical. Macrinite of earlier count considered as semifusinite (some structure present) in later count. The semifusinite present in this sample displays a continuum of structure from almost completely gelified prior to oxidation to well-preserved open cell lumens. Mineral matter by Parr is 1.2 vol.%.

PETROGRAPHIC ANALYSIS REPORT

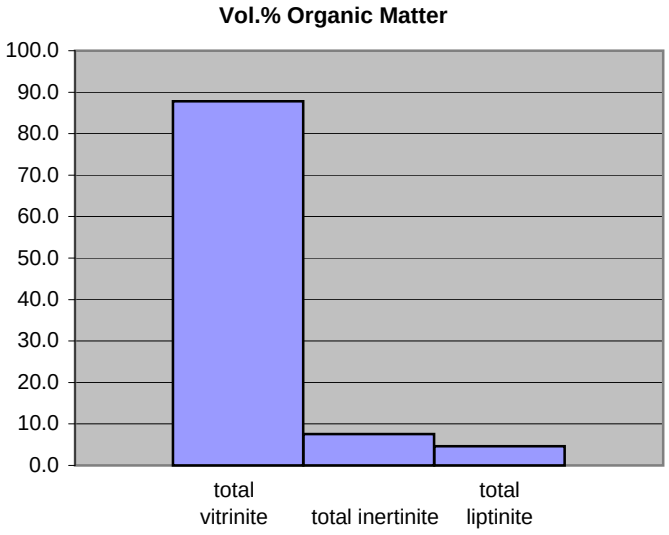
USGS

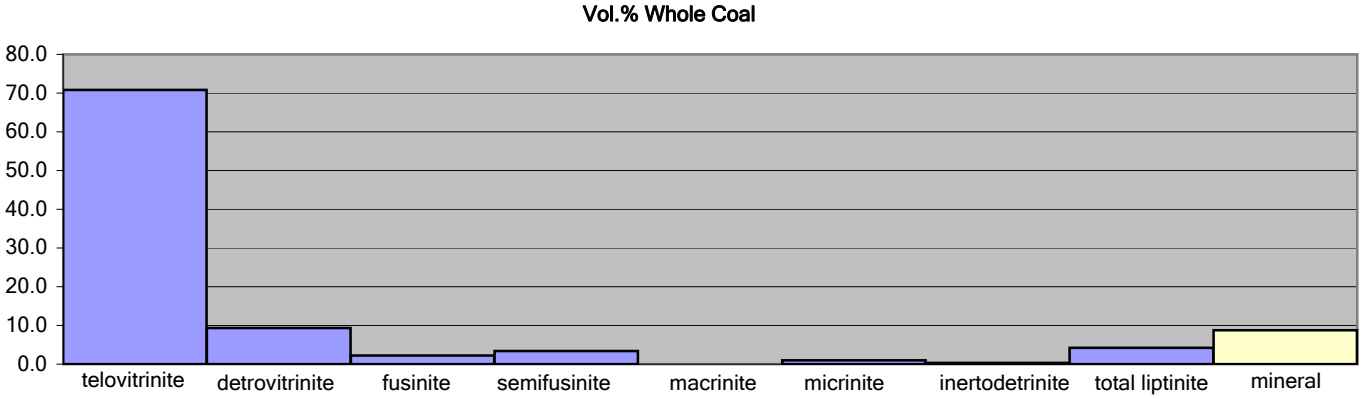
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	6/1/2006
Project:	Kolak
Sample:	**LM1-1.0**
Lab ID	141
Sample Type	no data
Date Analyzed:	1/25/2008
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	70.8	77.6
detrovitrinite	9.3	10.2
total vitrinite	80.1	87.8
fusinite	2.2	2.4
semifusinite	3.4	3.7
macrinite	0.0	0.0
funginite	0.0	0.0
secretinite	0.0	0.0
micrinite	1.0	1.1
inertodetrinite	0.3	0.3
total inertinite	6.9	7.6
sporinite	3.8	4.2
cutinite	0.1	0.1
resinite	0.3	0.3
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.0	0.0
other liptinite	0.0	0.0
total liptinite	4.2	4.6
mineral	8.8	
Total	100.0	100.0





COMMENT

Mineral matter calculated from Parr is 8.6 vol.%. Black Warrior basin coal.

PETROGRAPHIC ANALYSIS REPORT

USGS

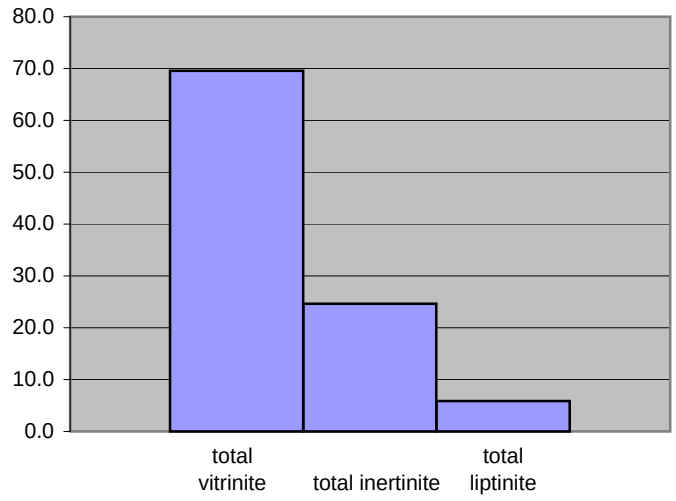
SAMPLE INFORMATION

Submitted by:	J. Kolak
Date Submitted:	9/9/2004
Project:	Kolak
Sample:	Cedar Grove
Lab ID	143
Sample Type	no data
Date Analyzed:	1/28/2008
Operator:	P. Hackley
#counts	1000
Rank:	high vol. bituminous

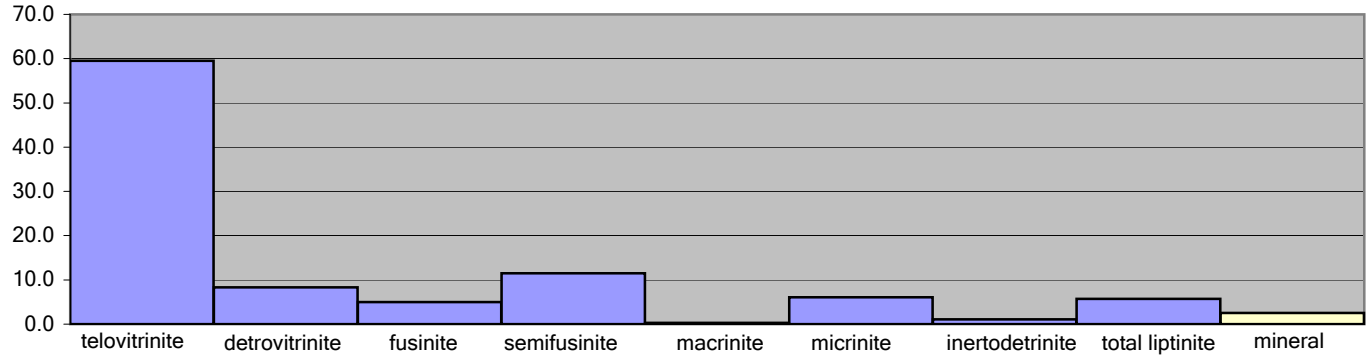
RESULTS

	Vol.% whole coal	Vol.% organic matter
telovitrinite	59.5	61.0
detrovitrinite	8.3	8.5
total vitrinite	67.8	69.5
fusinite	5.0	5.1
semifusinite	11.5	11.8
macrinite	0.3	0.3
funginite	0.0	0.0
secretinite	0.0	0.0
micrinite	6.1	6.3
inertodetrinite	1.1	1.1
total inertinite	24.0	24.6
sporinite	5.0	5.1
cutinite	0.4	0.4
resinite	0.3	0.3
suberinite	0.0	0.0
alginite	0.0	0.0
liptodetrinite	0.0	0.0
other liptinite	0.0	0.0
total liptinite	5.7	5.8
mineral	2.5	
Total	100.0	100.0

Vol.% Organic Matter



Vol.% Whole Coal



COMMENT

All 1000 points were counted on A pellet; B pellet has poor polish. Contains 2.4 vol.% mineral matter according to Parr.