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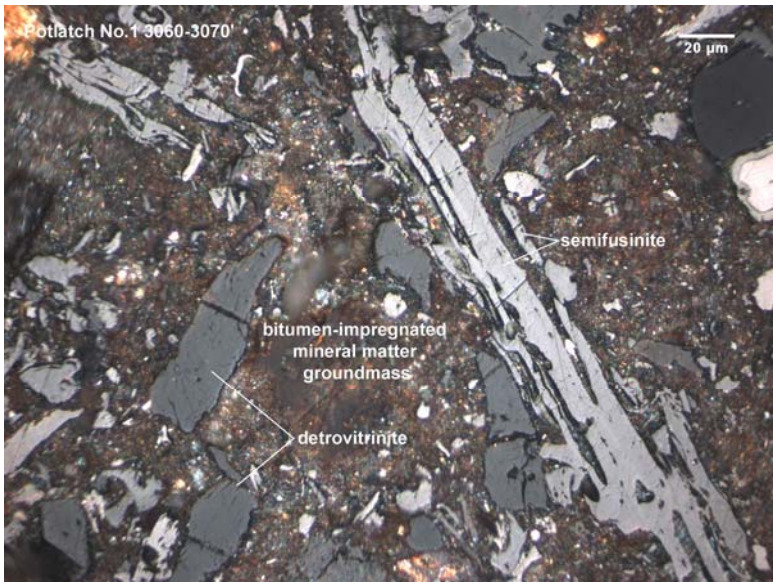
Reflectance Measurements of Well Cuttings from Ashley and Bradley Counties, Arkansas

By Paul C. Hackley[1], Michael E. Ratchford[2], and Peter D. Warwick[1]



Open-File Report 2006-1155

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Suggested citation:
Hackley, P.C., Ratchford, M.E., and Warwick, P.D., 2006, Reflectance measurements of well cuttings from Ashley and Bradley Counties, Arkansas: U.S. Geological Survey Open-File Report 2006-1155, 29 p., *http://www.pubs.usgs.gov/of/2006/1155/.*

Contents

Figures

Tables

Appendix

Reflectance Measurements of Well Cuttings from Ashley and Bradley Counties, Arkansas

By Paul C. Hackley, Michael E. Ratchford, and Peter D. Warwick

Introduction

Vitrinite reflectance measurements were determined for twenty-three well cuttings samples from Ashley and Bradley Counties, Arkansas, to evaluate coal rank and coalbed gas potential in the Desha Basin of the southern Mississisippi Embayment. Samples were selected from the Norman F. Williams Well Sample Library using geophysical logs to identify coaly shale and coal intervals from conventional oil and gas wells. Results indicate that maturation of vitrinite ranges from lignite to subbituminous B in the Wilcox Group (Paleocene-Eocene) at depths of 1400-2300 feet, and from subbituminous C to subbituminous A/high volatile bituminous C in the Trinity Group/Hosston Formation (Lower Cretaceous) at depths of 3000-3100 feet.

Procedure

Cuttings samples from five wells located in Ashley and Bradley Counties, Arkansas (fig. 1) were handpicked for coal fragments. The wells originally targeted hydrocarbons reservoired in the Jurassic Smackover Formation at depths of 5500-6000 feet during the 1960s-1970s. For this study, cuttings were collected from Wilcox and Trinity Group/Hosston Formation strata (fig. 1) at depths of 1400-3100 feet.

Collected cuttings were cast in epoxy and polished following the procedures outlined in Pontolillo and Stanton (1994). One mount was made for each sample. Measurement of random vitrinite reflectance in immersion oil ($R_{o\ ran}$) was performed according to the ASTM D2798 standard for coal (ASTM, 2005). The number of reflectance measurements per sample is less than ASTM protocol of 100.

Results

Determinations of the mean random reflectance of vitrinite range from 0.31-0.54 (summarized in Table 1). Many samples show some evidence of post-sampling oxidation and desiccation, including rinds, cracks, and patches of higher reflectance occurring in high-permeability pathways (fig. 2A-D). During analysis, care was taken to avoid areas containing obvious oxidation effects; however, some of the reflectance results may contain a possible bias toward higher values due to post-sampling oxidation. Heat flow and hydrothermal circulation from buried Upper Cretaceous igneous rocks (fig. 1) also may have impacted maturation of organic matter (e.g., Heydari and others, 1997) in some samples (Lower Cretaceous Trinity Group/Hosston Formation).

For rocks with dispersed organic matter, Barker and Pawlewicz (1993) recommended using a minimum of 20-30 measurements of indigenous vitrinite to calculate mean random reflectance. In several cases, insufficient sample was available to obtain a statistically significant number of measurements (<15); these values are noted in italic in Table 1, and should be considered suspect. Data for individual determinations of mean random reflectance, including a histogram of measurement data and description of the sample, are included in the Appendix.

Many of the cuttings samples contain fragments of well-developed coals (fig. 3A-D). Evaluation of historical geophysical logs from conventional oil and gas wells with respect to the location of the coaly intervals will be valuable for future coalbed gas exploration prospects in the Desha Basin.

References

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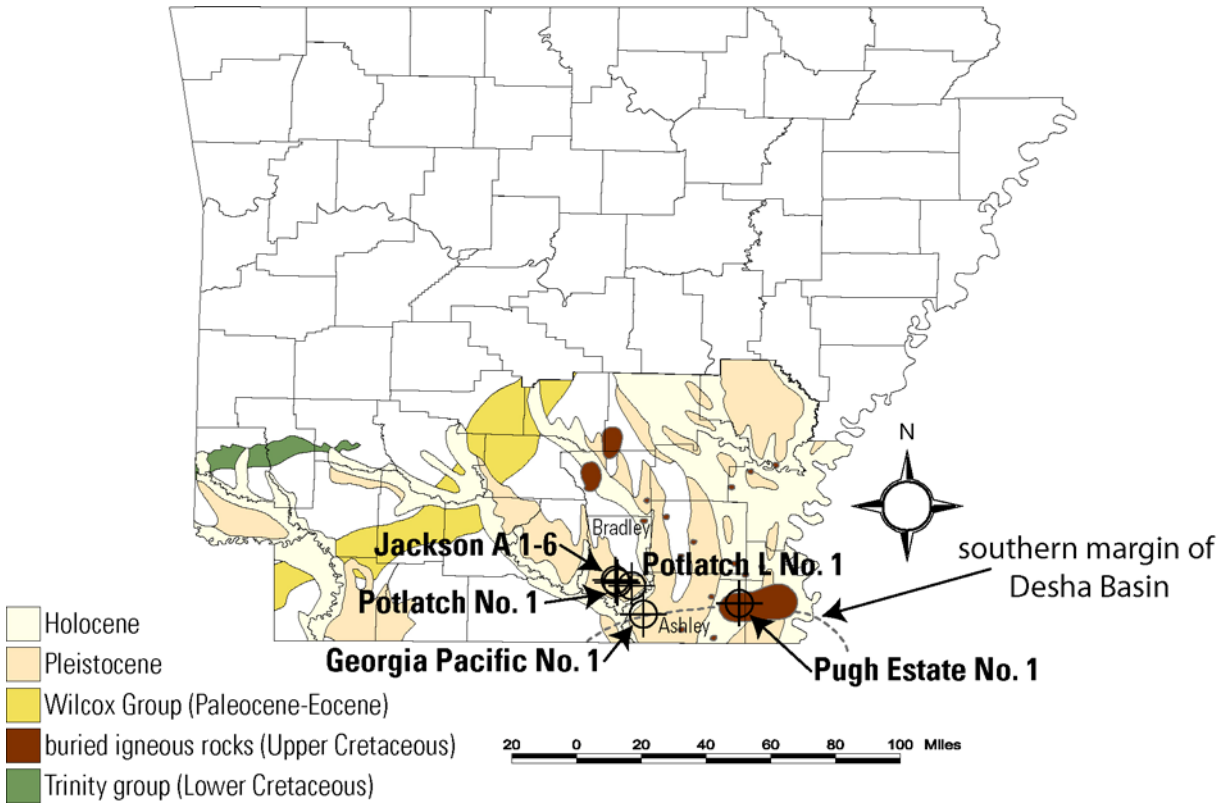


Figure 1. Location of conventional oil and gas wells collected from in this study, Bradley and Ashley Counties, Arkansas. Also shown are outcrop of coal-bearing strata (from Schruben and others, 1994), location of buried Upper Cretaceous igneous rocks (from Ewing and Lopez, 1991), and the southern margin of the Desha Basin (northern margin of the Monroe Uplift).

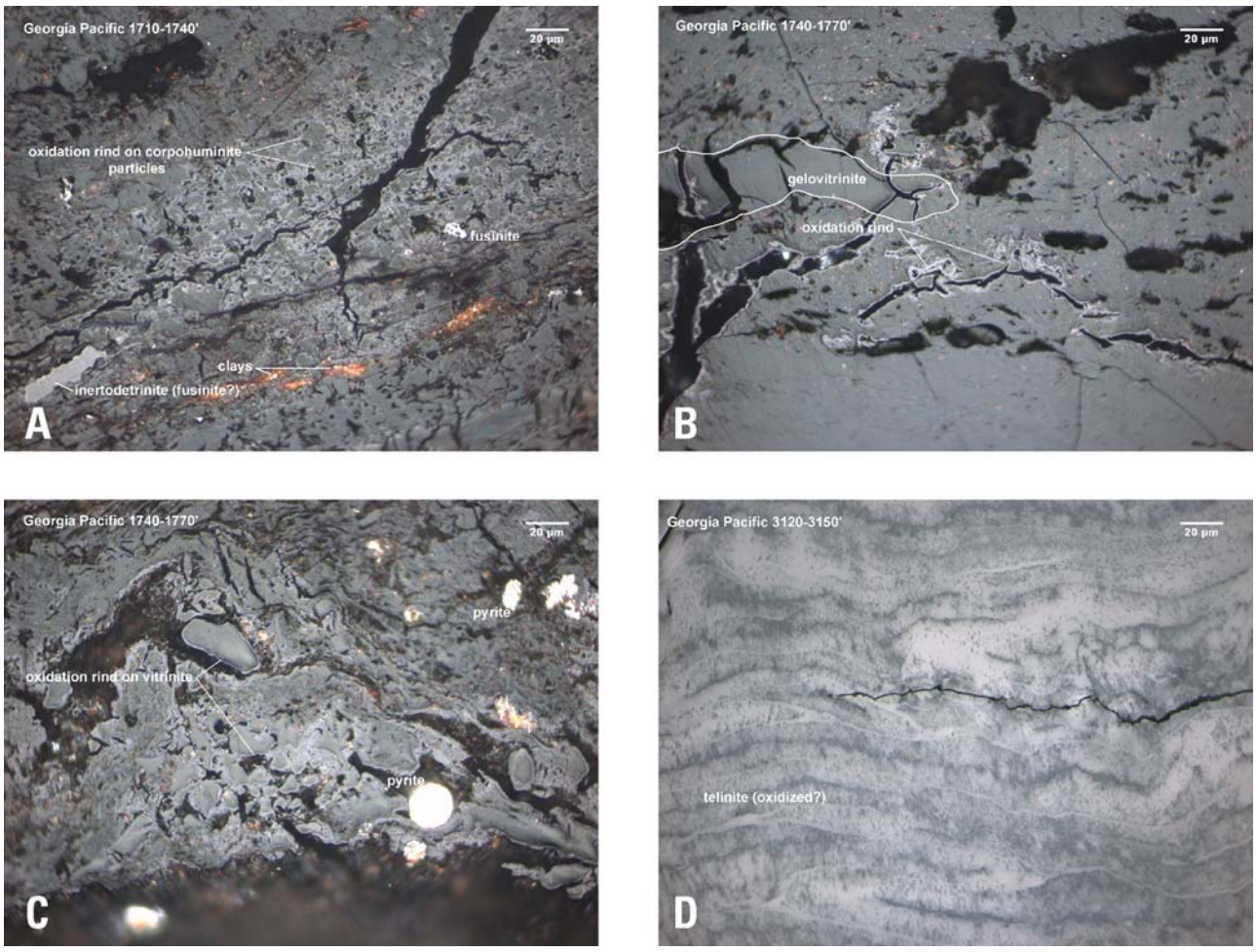


Figure 2. A-D) Examples of oxidized vitrinite from the Georgia Pacific No. 1 well. All under incident white light illumination in oil immersion.

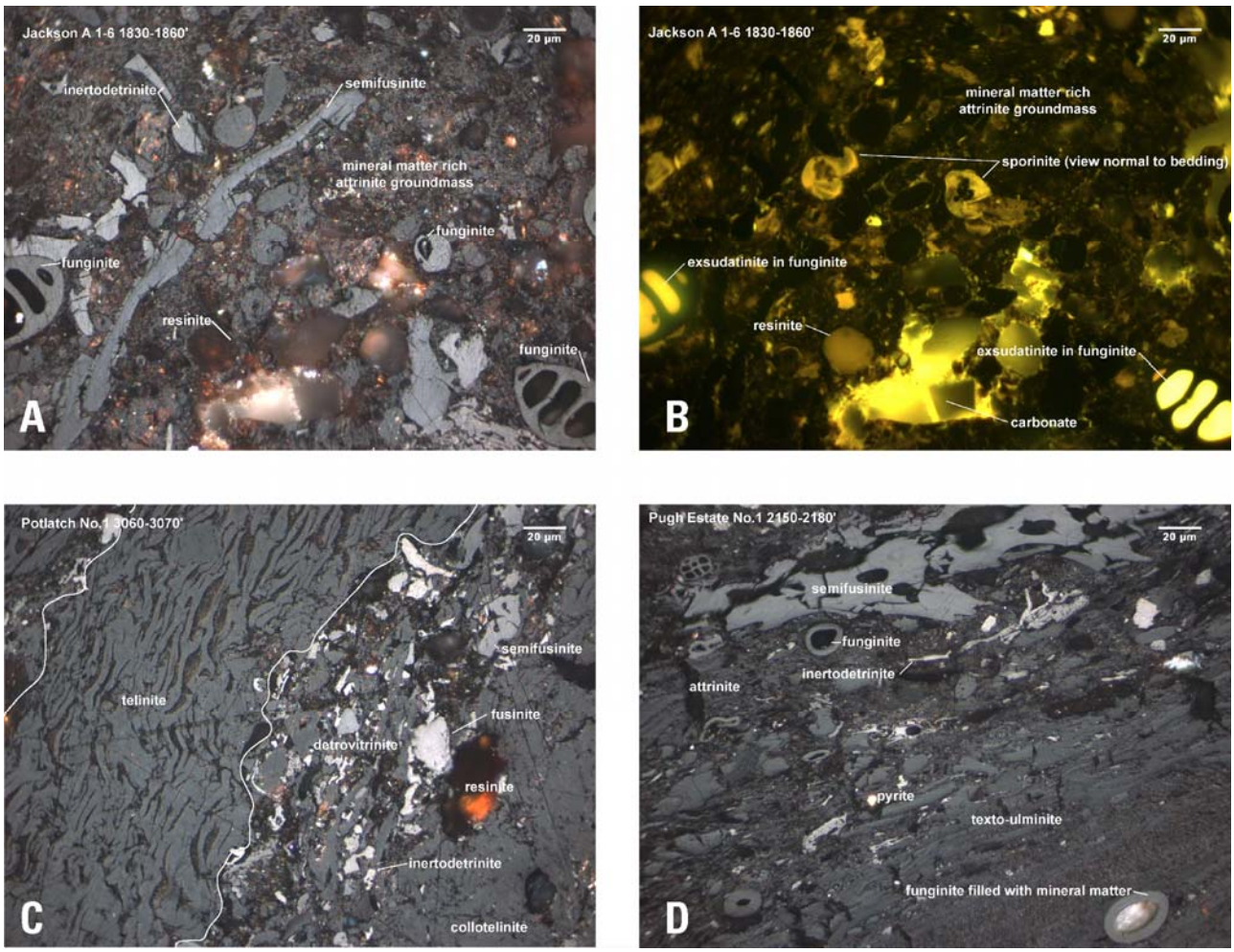


Figure 3. A-D) Photomicrographs from Jackson A 1-6 (A-B), Potlatch No. 1 (C), and Pugh Estate No. 1 (D). All under oil immersion in white light except B, which is the same field of view as A except under blue light illumination.

Table 1. Mean random reflectance measurements of well cuttings from Ashley and Bradley Counties, Arkansas.

Well Information	Sample ID	Stratigraphy	Age	$R_{o\ ran}$	s.d.	#measurements
Well: Potlatch L No. 1	Potlatch L No. 1 1810-1840'	Wilcox Group	Paleocene-Eocene	*0.31*	0.05	3
API: 03011100470000	Potlatch L No. 1 1840-1870'	Wilcox Group	Paleocene-Eocene	*0.31*	0.06	4
County: Bradley	Potlatch L No. 1 1870-1900'	Wilcox Group	Paleocene-Eocene	-	-	0
Latitude: 33.3172						
Longitude: -92.07861						
Well: Potlatch No. 1	Potlatch No. 1 3050-3060'	Trinity Group	Lower Cretaceous	0.54	0.07	15
API: 03011100770000	Potlatch No. 1 3060-3070'	Trinity Group	Lower Cretaceous	0.45	0.02	15
County: Bradley	Potlatch No. 1 3070-3080'	Trinity Group	Lower Cretaceous	0.47	0.04	15
Latitude: 33.3398						
Longitude: -92.17203						
Well: Pugh Estate No. 1	Pugh Estate No. 1 2150-2180'	Wilcox Group	Paleocene-Eocene	0.43	0.05	50
API: 03003100020000	Pugh Estate No. 1 2180-2210'	Wilcox Group	Paleocene-Eocene	0.43	0.04	40
County: Ashley	Pugh Estate No. 1 2210-2240'	Wilcox Group	Paleocene-Eocene	0.43	0.04	50
Latitude: 33.21525	Pugh Estate No. 1 2240-2270'	Wilcox Group	Paleocene-Eocene	0.42	0.05	25
Longitude: -91.49544	Pugh Estate No. 1 2270-2300'	Wilcox Group	Paleocene-Eocene	0.43	0.04	30
Well: Georgia Pacific No. 1	Georgia Pacific No. 1 1410-1440'	Wilcox Group	Paleocene-Eocene	0.37	0.02	19
API: 03003100340000	Georgia Pacific No. 1 1500-1530'	Wilcox Group	Paleocene-Eocene	0.43	0.04	50
County: Ashley	Georgia Pacific No. 1 1680-1710'	Wilcox Group	Paleocene-Eocene	0.43	0.05	50
Latitude: 33.16521	Georgia Pacific No. 1 1710-1740'	Wilcox Group	Paleocene-Eocene	0.38	0.04	20
Longitude: -92.01332	Georgia Pacific No. 1 1740-1770'	Wilcox Group	Paleocene-Eocene	0.43	0.04	25
	Georgia Pacific No. 1 1830-1860'	Wilcox Group	Paleocene-Eocene	*0.39*	0.04	7
	Georgia Pacific No. 1 3120-3150'	Trinity Group	Lower Cretaceous	0.40	0.04	25
Well: Jackson A 1-6	Jackson A 1-6 1770-1800'	Wilcox Group	Paleocene-Eocene	0.43	0.05	20
API: 03011100520000	Jackson A 1-6 1800-1830'	Wilcox Group	Paleocene-Eocene	0.41	0.05	30
County: Bradley	Jackson A 1-6 1830-1860'	Wilcox Group	Paleocene-Eocene	0.41	0.04	50
Latitude: 33.34907	Jackson A 1-6 3070-3080'	Trinity Group	Lower Cretaceous	0.39	0.05	50
Longitude: -92.17284	Jackson A 1-6 3080-3090'	Trinity Group	Lower Cretaceous	*0.35*	0.02	10

$R_{o\ ran}$ values listed in italic are based on a limited number of measurements and should be considered suspect.

APPENDIX: Vitrinite reflectance reports

VITRINITE REFLECTANCE REPORT

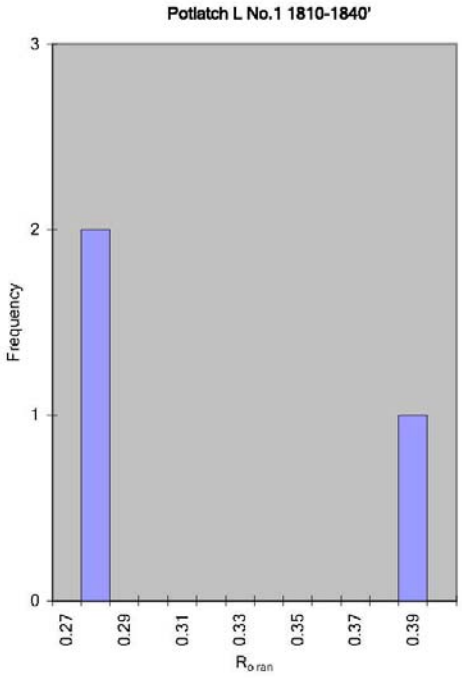
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Potlatch L No.1 1810-1840'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	3 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.31
s.d.:	0.05



DATA

0.277
0.388
0.278

min: 0.277 **max:** 0.388 **V-types:** 2

COMMENT

Insufficient organic material for analysis. Sample contains 5 rock fragments, 2 of which are mineral-matter rich detrovitrinite, with abundant liptinite fragments. One fragment is pyrite; one fragment is semifusinite with mineral-matter filled collapsed lumens. One fragment is rock with a few pieces of <10 micron vitrinite. Poor coal zone.

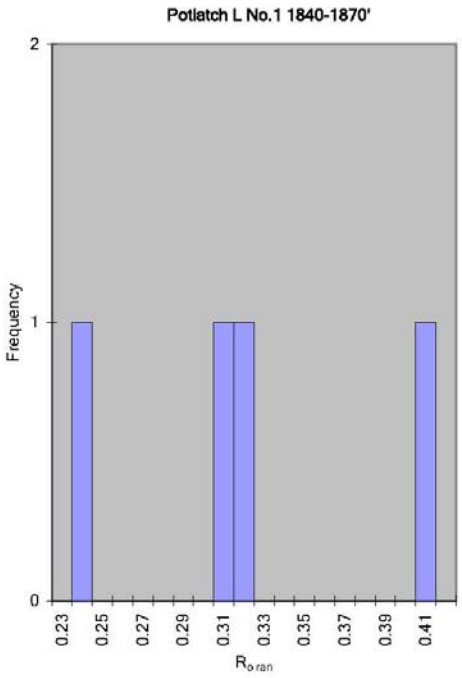
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Potlatch L No.1 1840-1870'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	4 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.31
s.d.:	0.06



DATA

0.301
0.239
0.311
0.404

min: 0.239 **max:** 0.404 **V-types:** 3

COMMENT

Insufficient organic material for analysis. Sample is comprised of 3 rock fragments; one is fusinite with pyrite-filled lumens, one is rock with dispersed vitrinite fragments, high polishing relief and dispersed sporinite and resinite. The third fragment is rock with dispersed vitrinite. Poor coal zone.

VITRINITE REFLECTANCE REPORT

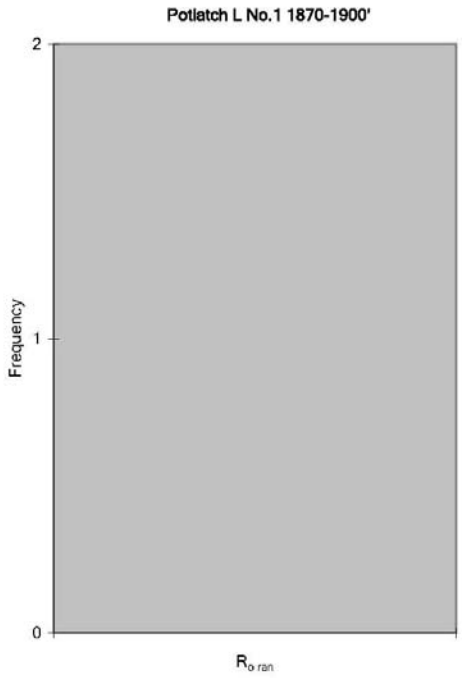
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Potlatch L No.1 1870-1900'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	0 <ASTM/ISO Standards
maceral type:	N/A
$R_{o\ ran}$ (ISO/ASTM):	N/A
s.d.:	N/A



DATA

min: 0.000 max: 0.000 V-types: 0

COMMENT

No data, insufficient unoxidized organic material for analysis. Sample contains 5 rock fragments; one is vitrinite with patches of oxidation via desiccation on linear pathways, a second contains sub- to euhedral pyrite + quartz. Two fragments are pyrite with cellular texture (wholesale replacement of textinite?), and the fifth is finely crystalline pyrite, possibly also replacing organic material.

VITRINITE REFLECTANCE REPORT

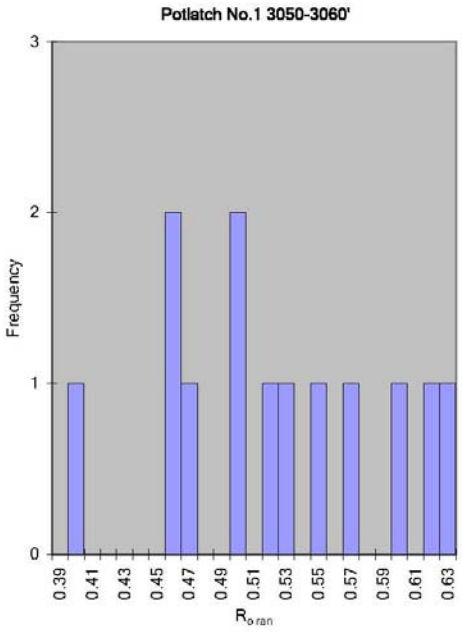
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	1/1/2004
Project:	Arkansas
Sample:	**Potlatch No.1 3050-3060'**
Sample Type	cuttings
Date Analyzed:	2/25/2004
Operator:	P.Hackley

RESULTS

# measurements:	15 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.54
s.d.:	0.07



DATA

0.616	0.567
0.454	0.458
0.633	0.515
0.593	0.629
0.526	0.643
0.497	
0.392	
0.496	
0.465	
0.547	

min: 0.392 **max:** 0.643 **V-types:** 4

COMMENT

Sample is approximately 10 coal fragments, repolished 5/5/06. Most are attrinite with reflectance values ranging between 0.5-0.6%. Three fragments are textinite with reflectance values >0.6%. Some of the textinite fragments displays obvious oxidation rinds.

VITRINITE REFLECTANCE REPORT

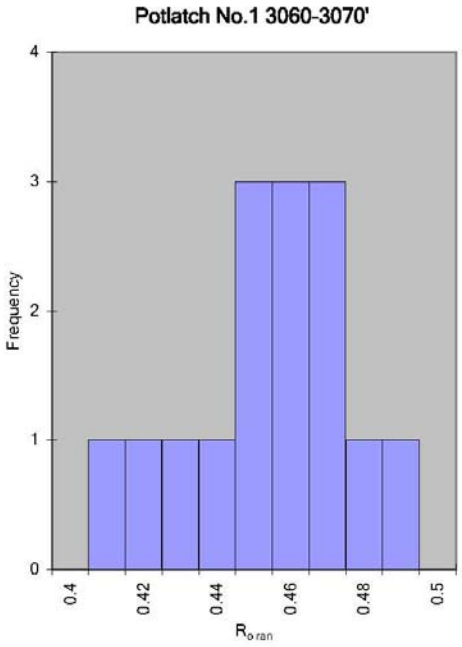
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	1/1/2004
Project:	Arkansas
Sample:	**Potlatch No.1 3060-3070'**
Sample Type	cuttings
Date Analyzed:	2/25/2005
Operator:	P.Hackley

RESULTS

# measurements:	15 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.45
s.d.:	0.02



DATA

0.407	0.458
0.447	0.478
0.437	0.457
0.452	0.468
0.467	0.430
0.412	
0.448	
0.463	
0.483	
0.442	

min: 0.407 **max:** 0.483 **V-types:** 1

COMMENT

Sample is approximately 10 coal fragments, repolished 5/5/06. Includes variable-reflecting textinite and layered attrinite-textinite.

VITRINITE REFLECTANCE REPORT

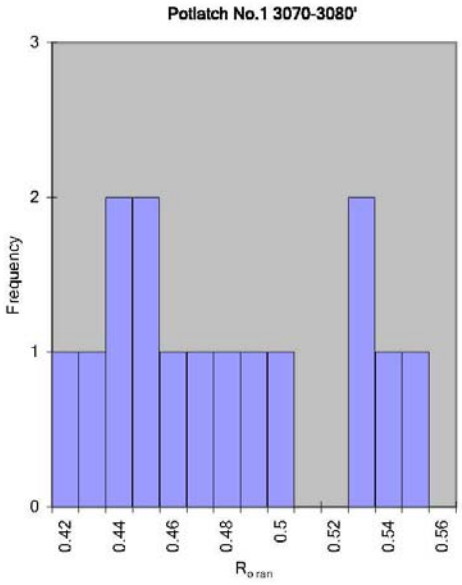
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	1/1/2004
Project:	Arkansas
Sample:	**Potlatch No.1 3070-3080'**
Sample Type	cuttings
Date Analyzed:	2/25/2004
Operator:	P.Hackley

RESULTS

# measurements:	15 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.47
s.d.:	0.04



DATA

0.470	0.432
0.548	0.420
0.471	0.423
0.452	0.528
0.532	0.529
0.499	
0.485	
0.446	
0.441	
0.432	

min: 0.420 **max:** 0.548 **V-types:** 2

COMMENT

Sample is approximately 30 coal fragments, repolished 5/5/06. Contains high reflecting textinite >0.6% with obvious oxidation rinds. For Potlatch No. 1 cuttings samples, possible reasons for variability in reflectance measurements include in-ground or post-drilling oxidation effects, proximity to possible buried Upper Cretaceous intrusives, high natural variability in vitrinite, and contamination from caving.

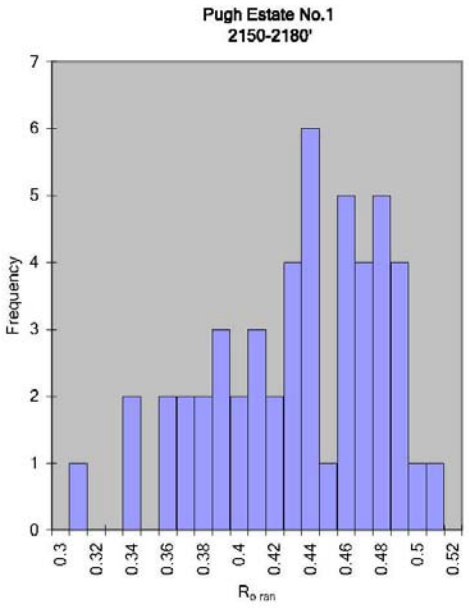
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	Pugh Estate No.1 2150-2180'
Sample Type	cuttings
Date Analyzed:	12/29/2004
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.05



DATA

0.482	0.482	0.413	0.384	0.479
0.365	0.365	0.360	0.337	0.484
0.444	0.444	0.372	0.426	0.405
0.431	0.431	0.392	0.479	0.436
0.436	0.436	0.392	0.406	0.431
0.472	0.472	0.307	0.433	0.509
0.469	0.469	0.455	0.369	0.404
0.465	0.465	0.461	0.475	0.389
0.357	0.357	0.427	0.390	0.378
0.482	0.482	0.453	0.339	0.438

min: 0.307 **max:** 0.509 **/-types:** 3

COMMENT

Sample contains 15-20 coal fragments on briquette surface. Dominated by telohuminite and detrohuminite containing fragments of cutinite, funginite, fusinite, and other coal macerals. Funginite similar to Wilcox funginite from northern Louisiana. Frequency of coal in cuttings indicates well-developed coal bed(s) are present in interval at this location.

VITRINITE REFLECTANCE REPORT

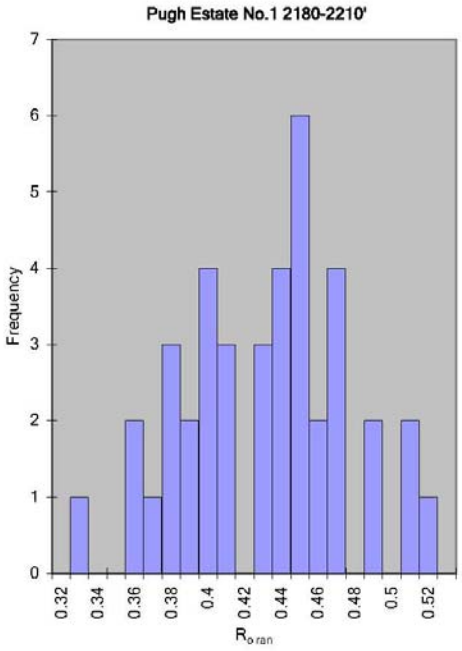
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Pugh Estate No.1 2180-2210'**
Sample Type	cuttings
Date Analyzed:	2/16/2005
Operator:	P.Hackley

RESULTS

# measurements:	40 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.04



DATA

0.470	0.443	0.446	0.405
0.374	0.485	0.369	0.486
0.390	0.373	0.429	0.399
0.396	0.395	0.434	0.392
0.355	0.443	0.462	0.428
0.382	0.448	0.516	0.439
0.410	0.509	0.436	0.444
0.455	0.457	0.375	0.403
0.435	0.504	0.462	0.427
0.450	0.463	0.328	0.353

min: 0.328 **max:** 0.516 **V-types:** 3

COMMENT

Sample contains 15-20 rock fragments on briquette surface. Fragments consist of telohuminite containing cutinite and leaf mesophyll, suberinite with in situ phlobaphanite, textinite with in situ resinite (var. fluorinite), ulminite, and detrohuminite with matrix resinite blebs, funginite, sporinite, and palynmorphs, and rare fusinite-inertodetrinite. Frequency of coal in cuttings indicates presence of well-developed coal bed(s).

VITRINITE REFLECTANCE REPORT

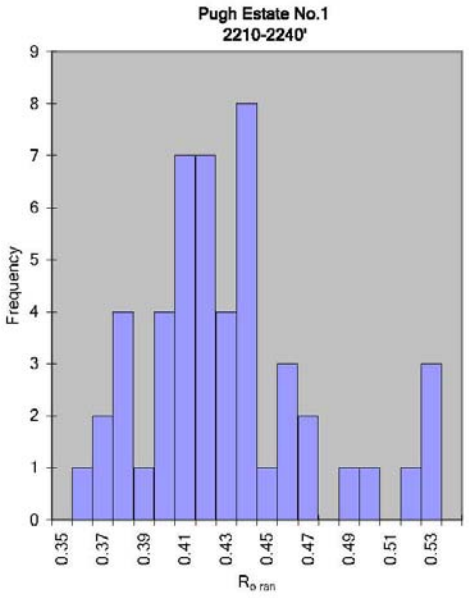
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	Pugh Estate No.1 2210-2240'
Sample Type	cuttings
Date Analyzed:	12/29/2004
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.04



DATA

0.391	0.391	0.439	0.419	0.432
0.463	0.463	0.396	0.522	0.406
0.453	0.453	0.363	0.500	0.488
0.414	0.414	0.375	0.436	0.439
0.464	0.464	0.384	0.455	0.413
0.459	0.459	0.367	0.429	0.433
0.407	0.407	0.437	0.377	0.525
0.393	0.393	0.423	0.418	0.524
0.356	0.356	0.378	0.414	0.372
0.417	0.417	0.432	0.402	0.430

min: 0.356 **max:** 0.525 **/-types:** 3

COMMENT

Sample contains approximately 15 rock fragments on briquette surface. High polishing relief. Contains Wilcox coal fragments similar in character to shallower Pugh Estate cuttings. Detrohuminite fragments contain more mineral matter than shallower samples and more of the fragments are rock with dispersed organic material, indicating coal beds are not as well-developed at this interval.

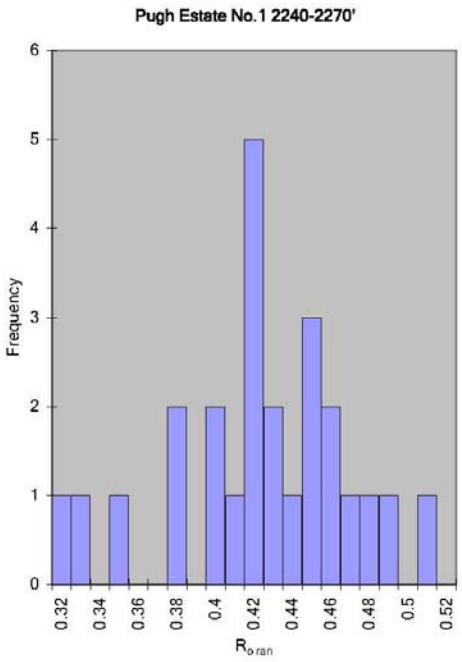
VITRINITE REFLECTANCE REPORT

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Pugh Estate No.1 2240-2270'**
Sample Type	cuttings
Date Analyzed:	2/16/2005
Operator:	P.Hackley

RESULTS

# measurements:	25 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.42
s.d.:	0.05



DATA

0.456	0.424	0.394
0.420	0.414	0.320
0.379	0.411	0.443
0.418	0.449	0.371
0.437	0.472	0.327
0.427	0.462	
0.396	0.453	
0.418	0.444	
0.508	0.341	
0.486	0.410	

min: 0.320 **max:** 0.508 **V-types:** 3

COMMENT

Sample contains approximately 15 coal fragments on briquette surface. High polishing relief. Fragments are of coal with telohuminite containing cutinite and leaf mesophyll, suberinite with in situ phlobaphanite, ulminite with internal reflections, and detrohuminite with matrix resinite blebs, funginite, sporinite, and palynmorphs, and less frequent fusinite-inertodetrinite. Frequency of coal in cuttings indicates well-developed coal bed(s).

VITRINITE REFLECTANCE REPORT

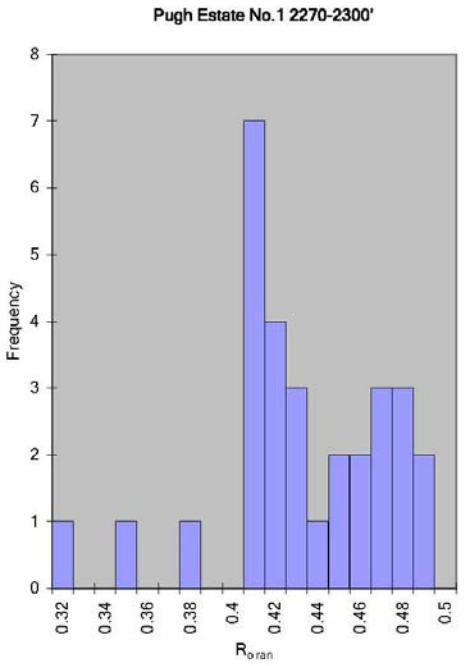
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	Pugh Estate No.1 2270-2300'
Sample Type	cuttings
Date Analyzed:	2/16/2005
Operator:	P.Hackley

RESULTS

# measurements:	30	<ASTM/ISO Standards
maceral type:	telohuminite	
$R_{o\ ran}$ (ISO/ASTM):	0.43	
s.d.:	0.04	



DATA

0.452	0.405	0.374
0.477	0.404	0.449
0.418	0.422	0.450
0.472	0.465	0.434
0.488	0.411	0.424
0.408	0.418	0.343
0.472	0.461	0.458
0.405	0.483	0.405
0.320	0.465	0.418
0.401	0.423	0.405

min: 0.320 **max:** 0.488 **V-types:** 2

COMMENT

Sample contains approximately 25-35 coal and rock fragments. High polishing relief. Contains telohuminite and detrohuminite fragments similar to shallower Pugh Estate samples. Telohuminite with preserved cellular structure including phlopbaphanite common, as is ulminite. Rounded resinite blebs common in detrohuminite, occurring with indertodetrinite, funginite, sporinite, liptodetrinite, and mineral matter. Frequency of coal fragments indicates well-developed coal beds are present in this interval.

VITRINITE REFLECTANCE REPORT

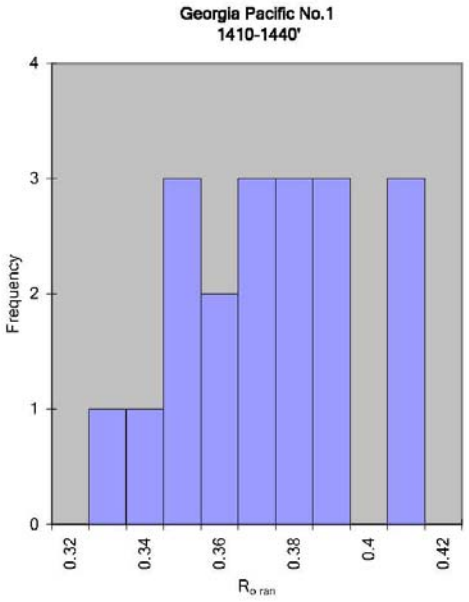
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	Georgia Pacific No.1 1410-1440'
Sample Type	cuttings
Date Analyzed:	2/4/2005
Operator:	P.Hackley

RESULTS

# measurements:	19
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.37
s.d.:	0.02



DATA

0.364	0.364
0.377	0.377
0.344	0.344
0.352	0.352
0.342	0.342
0.389	0.389
0.341	0.341
0.402	0.402
0.361	0.361
0.377	0.377

min: 0.341 max: 0.402 V-types: 2

COMMENT

Sample contains approximately 15 coal fragments. Dispersed and in situ resinite common. Suberinite present. High polishing relief. Coal fragments are mineral matter-rich. Multicellular funginite common. Frequency of coal fragments suggests well-developed coal beds are present in interval. Huminite similar in character to other Wilcox coal samples from southern Arkansas and northern Louisiana.

VITRINITE REFLECTANCE REPORT

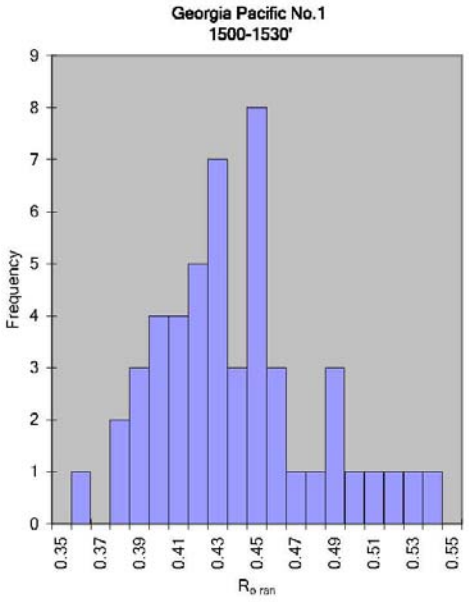
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 1500-1530'**
Sample Type	cuttings
Date Analyzed:	12/13/2004
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.04



DATA

0.530	0.530	0.432	0.472	0.421
0.430	0.430	0.446	0.449	0.481
0.381	0.381	0.448	0.464	0.447
0.410	0.410	0.357	0.434	0.401
0.427	0.427	0.423	0.407	0.422
0.449	0.449	0.413	0.484	0.397
0.396	0.396	0.517	0.371	0.421
0.445	0.445	0.507	0.421	0.445
0.418	0.418	0.396	0.376	0.446
0.386	0.386	0.402	0.415	0.492

min: 0.357 **max:** 0.530 **/-types:** 3

COMMENT

Sample contains approximately 20 coal fragments on surface of briquette. Dominated by Wilcox mineral matter-rich attrinite containing fragments of liptodetrinite, rounded resinite blebs, sporinite, funginite, inertodetrinite, and semifusinite. Higher mineral matter content than in 1410-1440 sample. High polishing relief.

VITRINITE REFLECTANCE REPORT

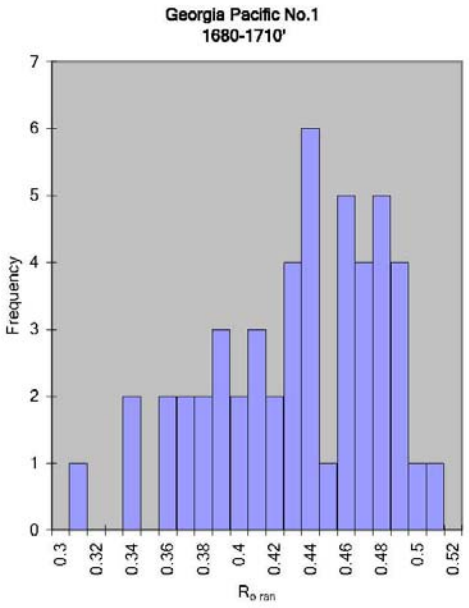
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 1680-1710'**
Sample Type	cuttings
Date Analyzed:	12/29/2004
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.05



DATA

0.482	0.482	0.413	0.384	0.479
0.365	0.365	0.360	0.337	0.484
0.444	0.444	0.372	0.426	0.405
0.431	0.431	0.392	0.479	0.436
0.436	0.436	0.392	0.406	0.431
0.472	0.472	0.307	0.433	0.509
0.469	0.469	0.455	0.369	0.404
0.465	0.465	0.461	0.475	0.389
0.357	0.357	0.427	0.390	0.378
0.482	0.482	0.453	0.339	0.438

min: 0.307 **max:** 0.509 **/-types:** 3

COMMENT

Sample contains approximately 25 coal fragments on surface of briquette. Textinite and ulminite contain internal reflections and are cracked from desiccation. Cutinite sheaths on leaf mesophyll containing in situ resinite (var. fluorinite) present. Less polishing relief than other Arkansas samples. Contains beautifully ornamented palynomorphs; well-preserved cutinite. Comprised of approximately equal proportions of Wilcox attrinite and textinite/texto-ulminite, suggesting well-developed coal beds present in interval.

VITRINITE REFLECTANCE REPORT

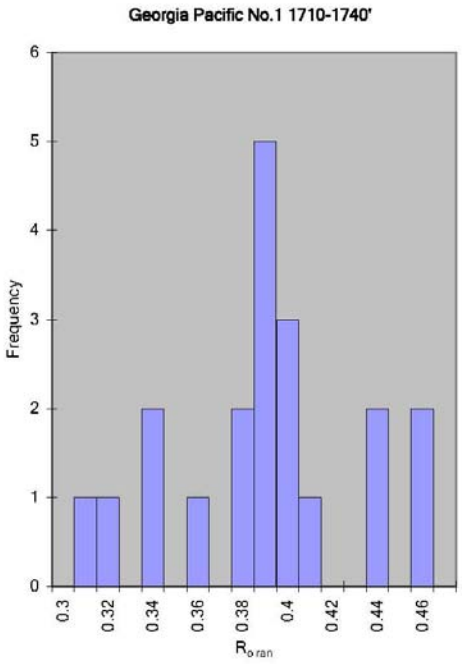
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 1710-1740'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	20 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.38
s.d.:	0.04



DATA

0.453	0.319
0.438	0.373
0.431	0.358
0.334	0.382
0.389	0.377
0.339	0.383
0.306	0.395
0.401	0.398
0.452	0.386
0.393	0.389

min: 0.306 **max:** 0.453 **V-types:** 2

COMMENT

Sample contains 12-15 coal and rock fragments on surface of briquette. Coal consists of Wilcox attrinite and textinite/texto-ulminite. Contains 1 cannel fragment. Multicellular funginite common. Oxidation rims on textinite indicate post-sampling desiccation.

VITRINITE REFLECTANCE REPORT

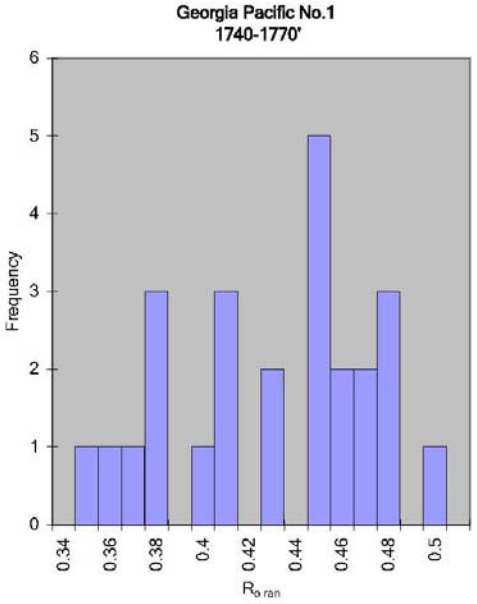
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 1740-1770'**
Sample Type	cuttings
Date Analyzed:	12/30/2004
Operator:	P.Hackley

RESULTS

# measurements:	25
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.43
s.d.:	0.04



DATA

0.410	0.369	0.350
0.451	0.426	0.380
0.442	0.425	0.467
0.500	0.377	0.455
0.480	0.356	0.445
0.445	0.405	
0.450	0.404	
0.445	0.471	
0.398	0.480	
0.468	0.377	

min: 0.350 **max:** 0.500 **V-types:** 2

COMMENT

Sample contains approximately 10 coal fragments on surface of briquette. Comprised of mineral matter-rich attrinite with multicellular funginite, sporinite, liptodetrinite, fusinite-semifusinite, and other maceral fragment inclusions. Oxidation rims on textinite indicate post-sampling desiccation. Some huminite is massive and structureless and may represent levigelinite.

VITRINITE REFLECTANCE REPORT

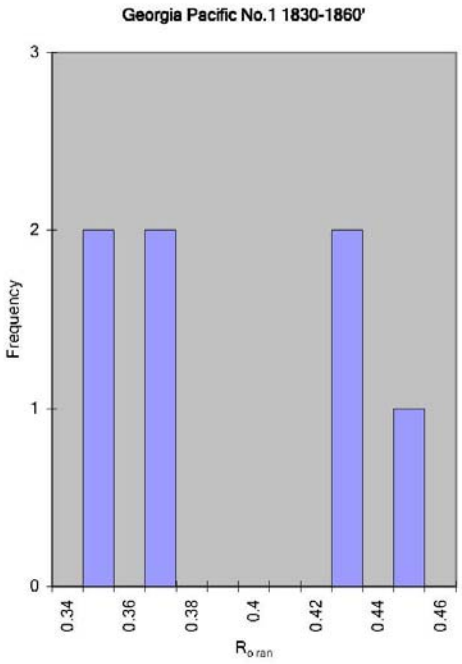
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 1830-1860'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	7 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.39
s.d.:	0.04



DATA

0.448
0.346
0.365
0.426
0.348
0.425
0.364

min: 0.346 **max:** 0.448 **V-types:** 2

COMMENT

Sample is comprised of approximately 25-30 coal fragments. Wilcox attrinite similar to previous higher interval dominates. High polishing relief. Desiccation cracks are common in texto-ulminite layers. Cracks do not propagate into adjacent attrinite layers.

VITRINITE REFLECTANCE REPORT

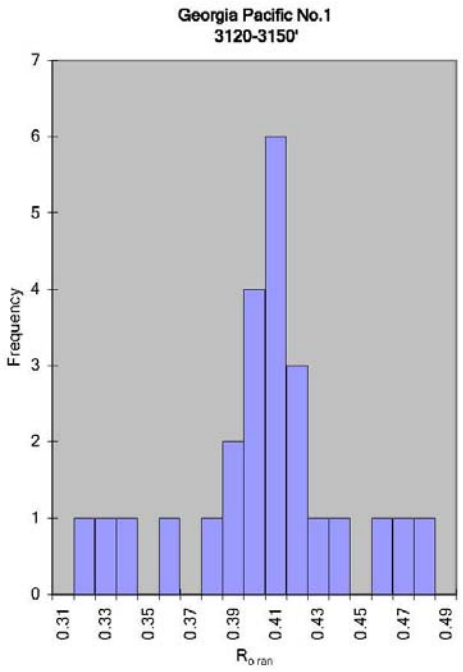
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Georgia Pacific No.1 3120-3150'**
Sample Type	cuttings
Date Analyzed:	2/5/2004
Operator:	P.Hackley

RESULTS

# measurements:	25 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.40
s.d.:	0.04



DATA

0.319	0.319	0.393
0.393	0.393	0.359
0.374	0.374	0.462
0.407	0.407	0.414
0.337	0.337	0.408
0.479	0.479	
0.399	0.399	
0.414	0.414	
0.432	0.432	
0.321	0.321	

min: 0.319 **max:** 0.479 **V-types:** 2

COMMENT

Sample is comprised of approximately 20 coal fragments. All are uniformly pyrite-mineralized textinite with some internal reflections; non-Wilcox, non-attrital coal. There are no other macerals present, i.e., no attrinite, no multicellular funginite, no other inertinite, no liptinite. Some reflectance measurements in range 0.6-0.9% likely due to post-sampling oxidation and desiccation.

VITRINITE REFLECTANCE REPORT

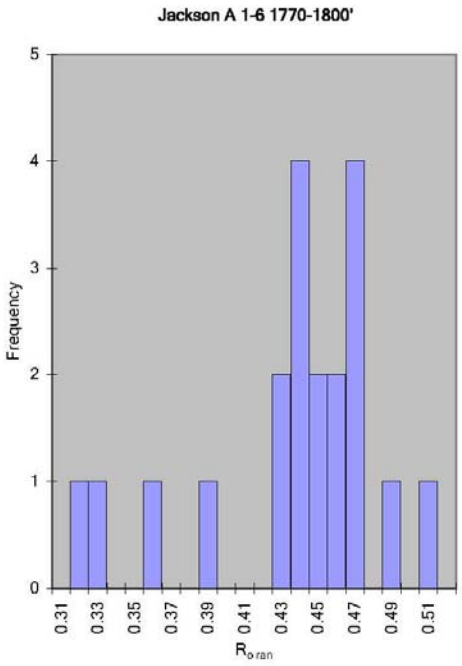
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Jackson A 1-6 1770-1800'**
Sample Type	cuttings
Date Analyzed:	2/16/2005
Operator:	P.Hackley

RESULTS

# measurements:	20	<ASTM/ISO Standards
maceral type:	telohuminite	
$R_{o\ ran}$ (ISO/ASTM):	0.43	
s.d.:	0.05	



DATA

0.461	0.430
0.490	0.358
0.436	0.322
0.439	0.433
0.458	0.388
0.426	0.462
0.505	0.439
0.452	0.318
0.468	0.442
0.443	0.470

min: 0.318 **max:** 0.505 **V-types:** 3

COMMENT

Sample is comprised of approximately 25-30 coal fragments. Wilcox attrinite is comprised of funginite, sporinite, liptodetrinite, resinite, semifusinite fragments in humic mineral matter-rich groundmass. Textinite contains internal reflections, desiccation cracks. One mineral matter-rich cannel fragment is present. Most of coal fragments are attrinite.

VITRINITE REFLECTANCE REPORT

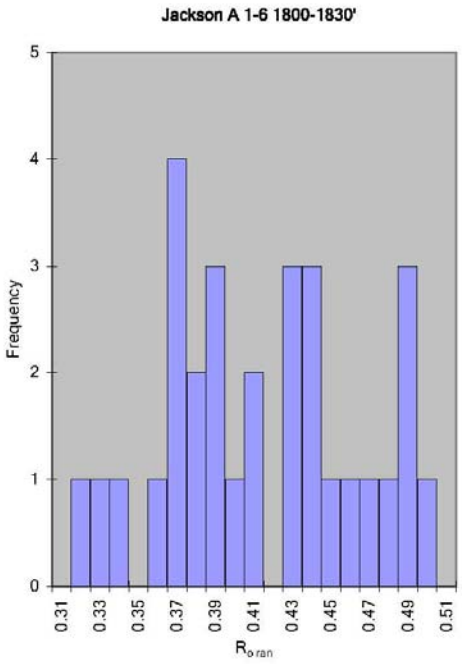
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Jackson A 1-6 1800-1830'**
Sample Type	cuttings
Date Analyzed:	2/16/2005
Operator:	P.Hackley

RESULTS

# measurements:	30 <ASTM/ISO Standards
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.41
s.d.:	0.05



DATA

0.490	0.378	0.459
0.472	0.492	0.364
0.367	0.426	0.484
0.443	0.481	0.426
0.383	0.429	0.392
0.366	0.322	0.338
0.440	0.439	0.364
0.384	0.406	0.318
0.404	0.464	0.431
0.373	0.385	0.358

min: 0.318 **max:** 0.492 **V-types:** 2

COMMENT

Sample is comprised of approximately 25-30 coal fragments. Wilcox attrinite similar to previous higher interval dominates. High polishing relief. Desiccation cracks are common in texto-ulminite layers. Cracks do not propogate into adjacent attrinite layers.

VITRINITE REFLECTANCE REPORT

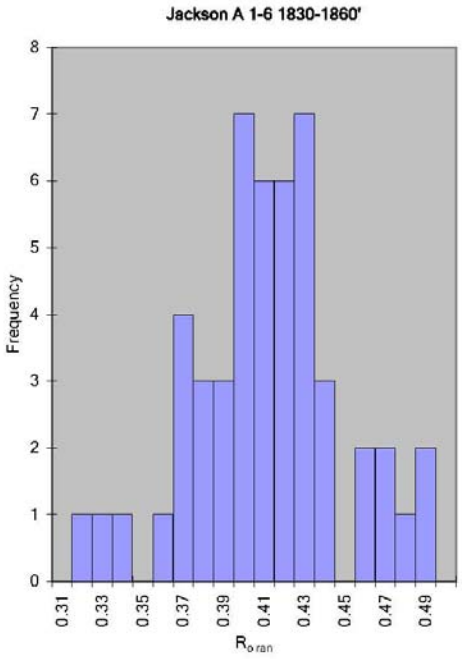
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Jackson A 1-6 1830-1860'**
Sample Type	cuttings
Date Analyzed:	2/15/2005
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.41
s.d.:	0.04



DATA

0.481	0.390	0.408	0.424	0.362
0.469	0.485	0.336	0.417	0.426
0.414	0.311	0.434	0.419	0.391
0.401	0.408	0.392	0.426	0.431
0.402	0.369	0.422	0.377	0.414
0.398	0.381	0.363	0.409	0.453
0.401	0.462	0.325	0.426	0.427
0.416	0.398	0.378	0.391	0.389
0.363	0.371	0.421	0.419	0.392
0.474	0.440	0.397	0.356	0.452

min: 0.311 **max:** 0.485 **V-types:** 2

COMMENT

Sample is comprised of approximately 40 coal fragments. Wilcox coal with mineral matter-rich attrinite and desiccated textinite with internal reflections. Coal fragments divided approximately evenly between attrinite and textinite/texto-ulminite. Wilcox multicellular funginite common in attrinite.

VITRINITE REFLECTANCE REPORT

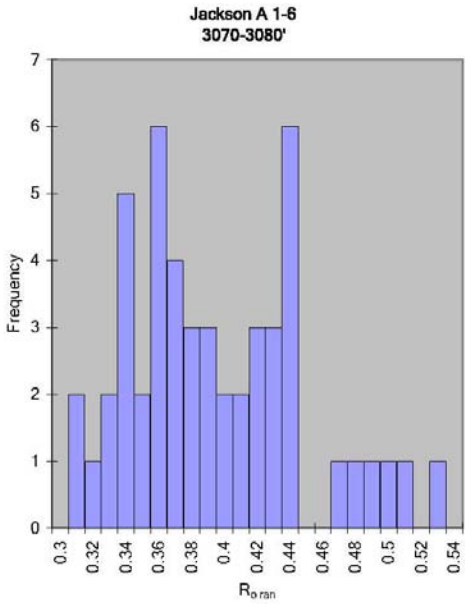
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Jackson A 1-6 3070-3080'**
Sample Type	cuttings
Date Analyzed:	2/4/2005
Operator:	P.Hackley

RESULTS

# measurements:	50
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.39
s.d.:	0.05



DATA

0.430	0.358	0.475	0.358	0.395
0.499	0.314	0.346	0.359	0.357
0.502	0.386	0.381	0.363	0.338
0.408	0.434	0.304	0.367	0.328
0.382	0.361	0.439	0.334	0.379
0.339	0.412	0.378	0.484	0.358
0.424	0.405	0.308	0.413	0.438
0.422	0.349	0.321	0.380	0.431
0.466	0.528	0.440	0.397	0.370
0.332	0.336	0.432	0.358	0.411

min: 0.304 **max:** 0.528 **/-types:** 3

COMMENT

Sample comprised of approximately 30 coal fragments. Wilcox attrinite and textinite, and carbonaceous shale fragments with dispersed organics present. Some textinite of character similar to Georgia Pacific 3120-3150 is present. Possible that Wilcox attrinite is from caving higher in hole? Multicellular funginite is present in attrinite. Some fragments contain textinite (less pyrite mineralization) with adjacent layers of attrinite.

VITRINITE REFLECTANCE REPORT

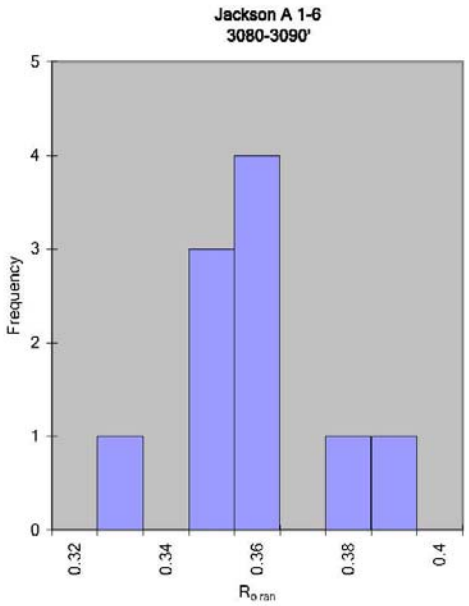
USGS

SAMPLE INFORMATION

Submitted by:	E.Ratchford
Date Submitted:	9/9/2004
Project:	Arkansas
Sample:	**Jackson A 1-6 3080-3090'**
Sample Type	cuttings
Date Analyzed:	2/4/2005
Operator:	P.Hackley

RESULTS

# measurements:	10
maceral type:	telohuminite
$R_{o\ ran}$ (ISO/ASTM):	0.35
s.d.:	0.02



DATA

0.352	0.352
0.359	0.359
0.344	0.344
0.356	0.356
0.342	0.342
0.325	0.325
0.358	0.358
0.343	0.343
0.378	0.378
0.384	0.384

min: 0.325 **max:** 0.384 **/-types:** 1

COMMENT

Sample contains 10 coal fragments. Attrinite with multicellular funginite common. Two fragments are textinite. Same observations as Jackson A 1-6 3070-3080.