GOALS of the STUDY

A better understanding of gas quality in the state can be achieved if chemical data for natural gases are compiled and examined with respect to their geology, depth, and location. Understanding trends in gas quality is the first step in determining the pay zones, plays, and volumetric importance of any low-BTU gas resources. In addition, any helium present in a natural gas could be a significant value added to that of the hydrocarbon

DATA SOURCES and PREPARATION

Chemical compositions of natural-gas tests are available from a several publications (cf., Jenden and others, 1988), U.S. Bureau of Mines Circulars (cf., Moore, 1982) and unpublished sources (e.g., unitization hearings, scout cards, information donated by operators).

ANALYTICAL LABORATIORY, INC. COMPANY NAME: OSEORN EMERGY LABO 9827398 NAMPLE ID: TOM MEYERS #3 SETT M: TOM MEYERS #3 COUNTY: N/A LEGAL LOCATION: N/A-DATE SAMPLED: MARCH 17 1998 SAMPLEM: OE SAMPLE PRESSURE: 1000 TEMPERATURE (F): N/A DATE ANALYZED: MARCH 18 1998 OUALITY CONTROL DATE: MARCH 18 1998 Plus Desertion LAB

donated by oil & gas producer)

These data were compiled in a spreadsheet database. Using this spreadsheet, gas compositions were corrected for possible atmospheric contamination based on oxygen content of the sample and atmospheric ratios of other gases to oxygen. Most significant is the correction for nitrogen, which is 3.72 times that of the oxygen percentage in a sample.

(example of part of the spreadsheet)

COUNTY	FIELD	OPERATOR	WELL NAME	LOCATION	1	API#	PROVINCE (AAPG)	DATUM (ft)		AGE	FM.			CARBORS.	CONTRACTOR OF THE PARTY OF THE	and the same of	hadden.	Name and	John whater	cyclopentene	Farmer		NON-HYD		and the second s	+He Hydroge	carbon diox	de halium		SPEC, GRAV.	REFERENCE
				Sec. Tns	np. Rnge.	J		(14)	0.0					74	PiO.	204	PhO.	OS	294	Phi	790	014	(%)	(%)	(96) (96)	(%)	(%)	(%)			
McPherson	Voshell	W.C. McBride	Krehbiel #2	4 21	3 W	15-145-00411	Sedgwick basin	1455	1773	Ordovician	Arbuckle		5513	3.6	1.8	0.2	4.5	0.2	0.1	fracei	9.2		29:9	0.3	0.2	0.1	(not given)	3.28	766	5 0.733	Boone (1958)
Rice	Bull Creek	Hummon Oil	Bell #1	15 21	8 W	15-145-01257	Central Kansas uplift	1641	2530	Ordovician	Arbuckle		65.8	43	12	1.2	1.6	0.3	0.3	0.1	0.1		21.1	0.1	0.1	trace	(not given)	2.37	922	0.737	Boone (1958)
Rice	McClintock	Ben C.W. Hyde, Jr.	McClintock#1	18 21	8 W	15-145-01494	Central Kansas uplift	1654	2497	Ordovician	Arbuckle		45.5	9.1	19	0.8	E.A.	0.2	0.2	4.1	6.5		24.0	0.1	0.1	trace	(not given)	2.66	852	2 0.723	Boone (1958)
Rice	Fitzpatrick	Northeastern Petroleum	Fitzpatrick #1	30 21	8 W	(not given)	Central Kansas uplift	1652	2663	Ordovician	Arbuckle		68.5	13.2	7.0	1.5	15	0.5	0.1	0.1	8.4		8.6	0.1	0.1	trace	(not given)	0.33	1243	0.813	Boone (1958)
Rice		Northeastern Petroleum											79.4	Instit given	. Inot given)	Onot please	Inot given	Dook please	friet giversi	inst giveni	Inotigives	0.11.9	(not given	0.4	(not given) 6.6	(not give	n) (not given)	0.92	1052	0.650	Anderson and Hinson (1951)
Rice	Tobias	Renfro Drilling	Schuyler #1	3 21	9 W	15-145-20328	Central Kansas uplift	1681	1666	Ordovician	Arbuckle			3.2			8.6	0.0	9.3	trace	0.1		66.1	0.0	0.2	trace	0.5	3.98	391	0.876	Moore (1976)
Rice	Canzoneri	Lebsack Oil Production	Canzoneri #1	10 21	9 W	15-145-20548	Central Kansas uplift	1675	2002	Permian	Chase																		800	(not given)	scout cards
Rice	Tobias	I.O. Miller	Lipp #1	11 21	9 W	15-145-21379	Central Kansas uplift	1673	1349	Permian	Chase	Winfield	57.4	0.5	trece	10.8	80	0.8	0.0	0.0	80		40.9	0.3	0:1	trace	0.1	1.25	589	0.725	Hamak and Sigler (1993)
Rice	Alden	Sharon Drilling	Small.#1	22 21	9 W	15-145-21269	Central Kansas uplift	1670	1280	Permian	Chase	Nolans																	609	(not given)	scout cards
Rice	Fitzpatrick	Lebsack Oil Production	Dill #1	24 21	9 W	15-145-21269	Central Kansas uplift	1662	1014	Permian	Chase	Winfield, Doyle	2																769	(not given)	scout cards
- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1						1.5.1.1.1	the second second second					V 41 11 1 1 1 1 1																			

GEOLOGIC ANALYSIS

Comparison of gas chemistries by age of pay zone was facilitated by subdividing the stratigraphic column into 6 parts (see Panel 3, to left):

- 1. Permian.
- 2. Pennsylvanian, Virgilian.
- 3. Pennsylvanian, Missourian.
- 4. Pennsylvanian, Desmoinesian & lower groups.
- 5. Mississippian and older formations subcropping and overlying the basal Pennsylvanian angular unconformity.
- 6. Sub-Mississippian strata not subcropping beneath the basal Pennsylvanian angular unconformity.

DATA ANALYSIS

Variations of gas chemistry with age of reservoir were examined by comparing distributions of the gas characteristics (i.e., heating value, hydrocarbon wetness, % noncombustible gases, N₂:He ratio) within each stratigraphic interval. The most commonly reported characteristic is the BTU content (heating value) of a gas, which is dependent on gas chemistry.

SPATIAL ANALYSIS

The southern half of Kansas was subdivided into three smaller regions -- west, central, and east-central. Chemical characteristics were then mapped. Plays and chemical trends could then be defined by pay zone and location.

COMPONENT GASES in NATURAL GAS

The heating value of a natural gas is reported as its BTU content (i.e., BTU/standard cubic ft). Heating value is a function of the type of hydrocarbon and nonhydrocarbon gases present in a sample. Methane, commonly the main hydrocarbon component in a natural gas, has a heating value of 1057 BTU/scf. Higher-molecular-weight gases have greater BTU content (see below) and will increase the heating value of a natural gas, whereas noncombustible gases will decrease the heating BTU/scf vs. %(N+He+Ar)

HYDROCARBONS

1847 BTU/scf ethane (C₂H₆)

nitrogen (N₂) helium (He) argon (Ar) hydrogen (H₂)

NON-HYDROCARBONS

carbon dioxide (CO₂) hydrogen sulfide (H₂S)

analysis from one well

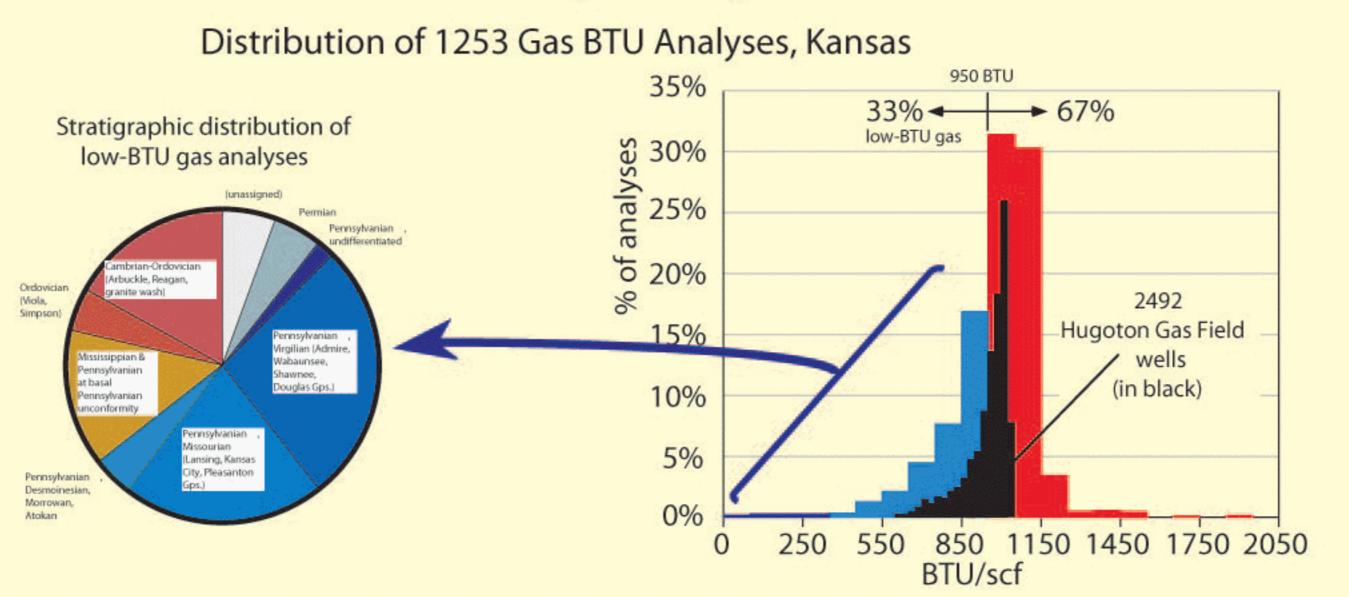
volume % of nitrogen, helium, and argon Permian gases in central Kansas are dry gases (i.e., hydrocarbon component mostly composed of methane). A dry natural gas can contain no more than ~10% nonhydrocarbon gas before it has <950 BTU/scf.

0 10 20 30 40 50 60 70 80

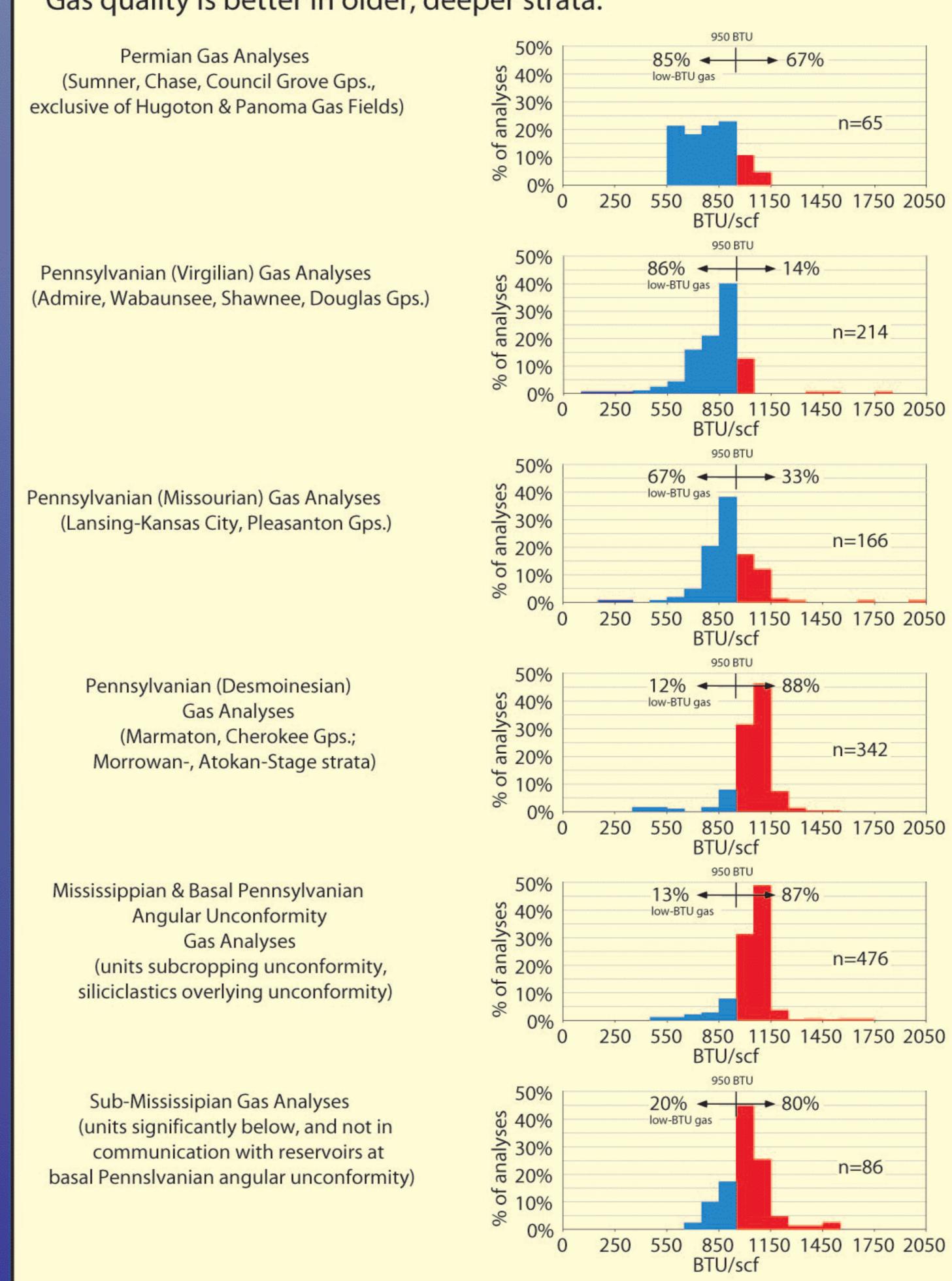
of PERMIAN GASES, CENTRAL KANSAS

GAS QUALITY (example of typical gas analysis

"Low-BTU natural gas" has a heating value of <950 BTU/scf. 950 BTU/scf is a cutoff commonly imposed by pipeline companies. A histogram of heating values for Kansas gases exclusive of the Hugoton and Panoma Gas Fields (shown below) indicates that low-BTU gases are a flank on a skewed distribution. One-third of these gas analyses are low-BTU.



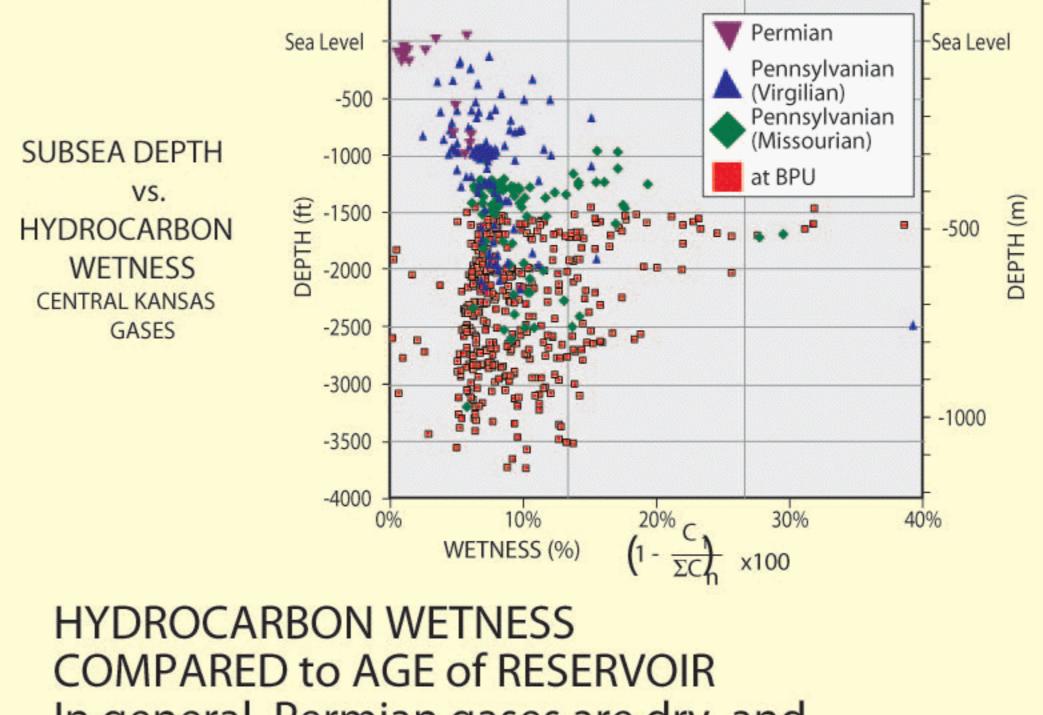
HEATING VALUE COMPARED to AGE of RESERVOIR Histograms of heating values with respect to age of the reservor indicate that Permian and upper Pennsylvanian (Virgilian, Missourian) strata are dominated by low-BTU gas. Gas quality is better in older, deeper strata.



SUMMARY

Mississippian & basal Penn. unc. sub-Mississippian 0% 25% 50% 75% 100% % analyses with <950 BTU/scf

Mississippian & basal Penn. unc. sub-Mississippian



Hydrocarbon wetness is a measure of the

heavier-molecular-weight gases in a natural

including type of source-rock organic matter,

gas. It is influenced by several factors,

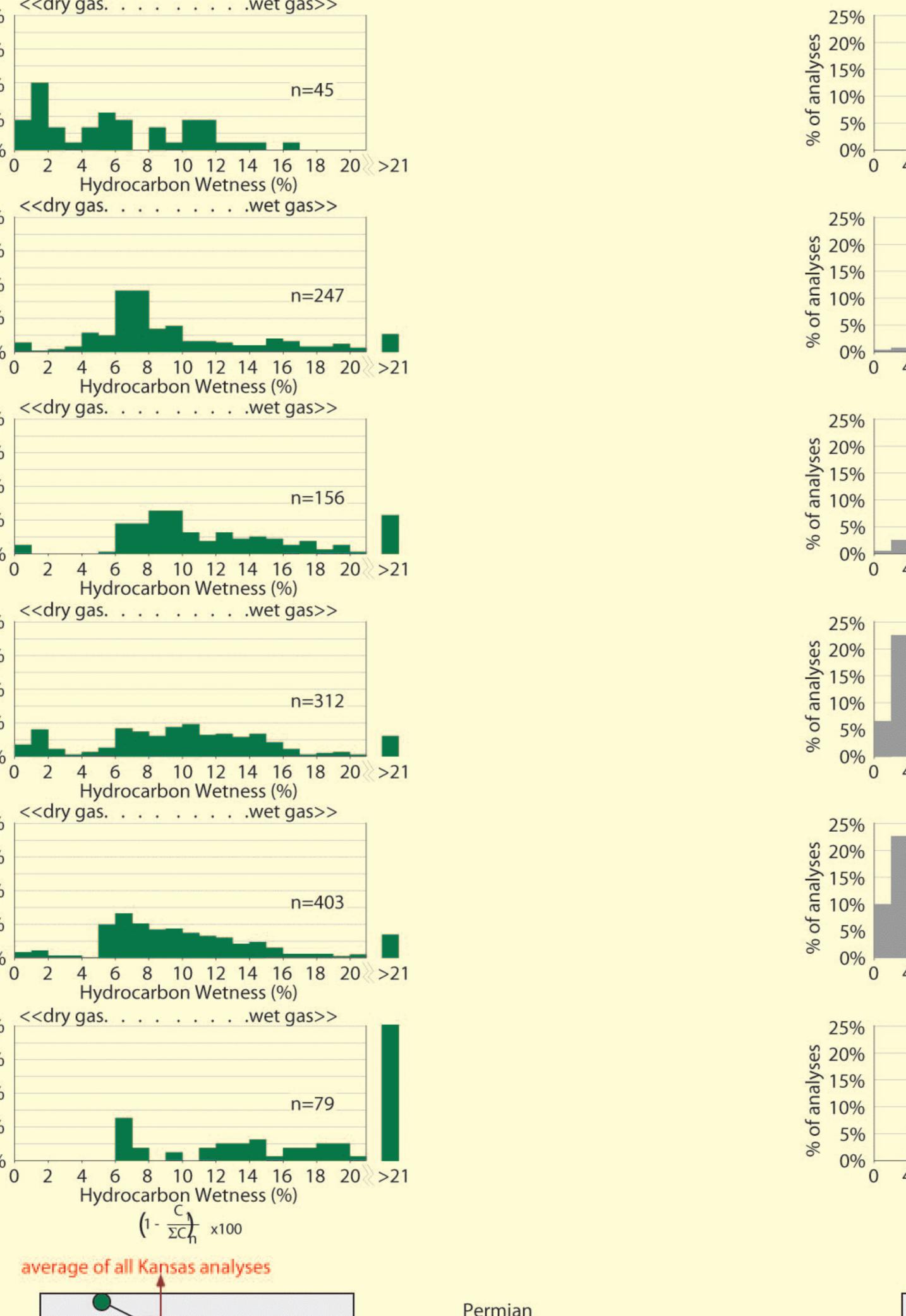
contact.

maturation, and proximity to the gas/oil

In general, Permian gases are dry, and hydrocarbon wetness increases with increasing age and depth of the reservoir.

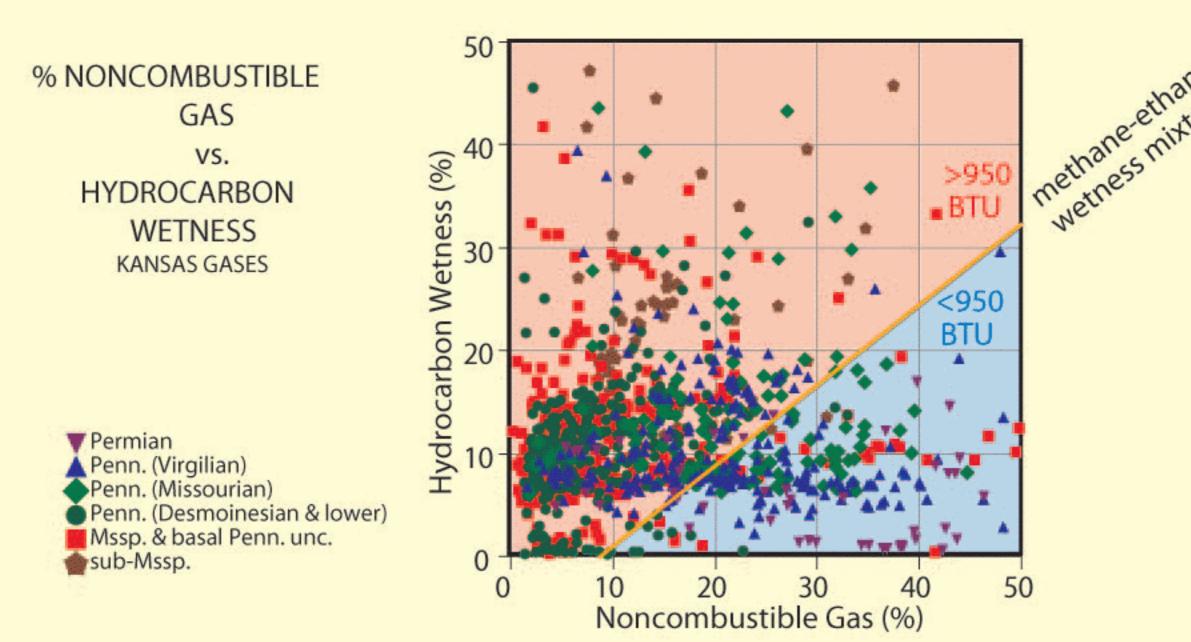
10% 20% 30%

average % wetness

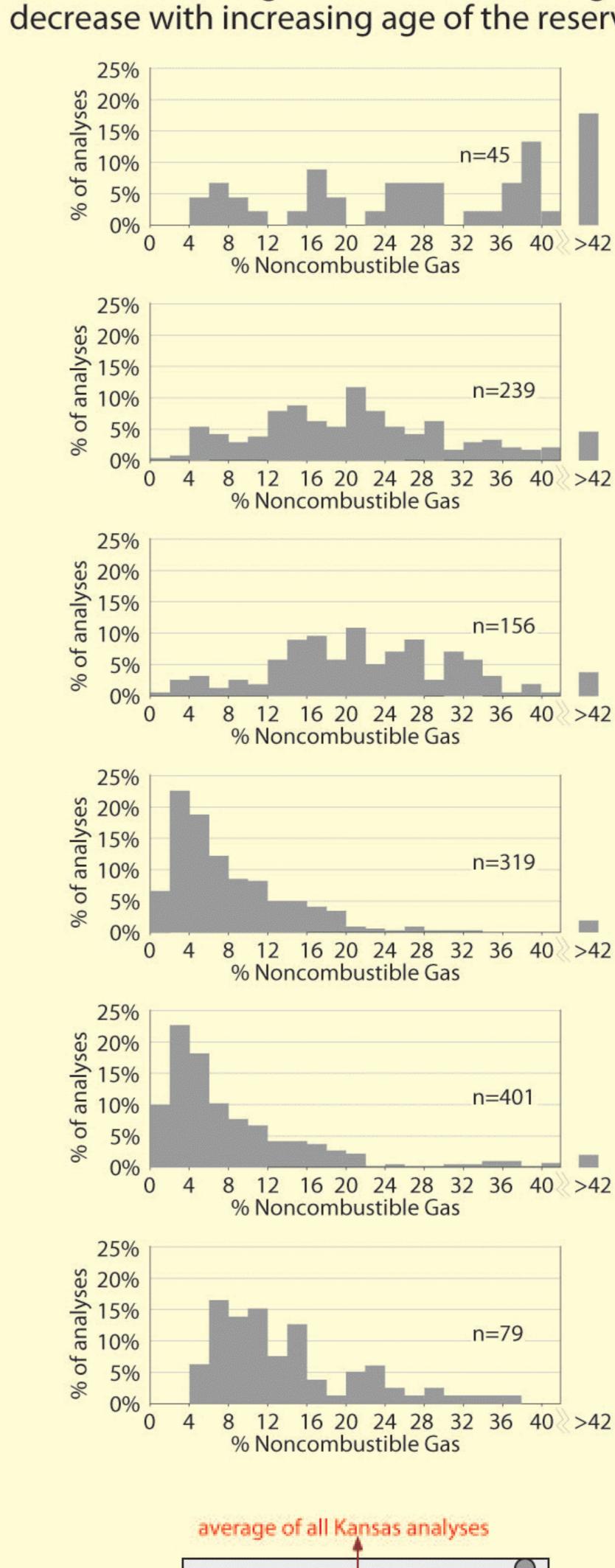


Pennsylvanian (Virgilian) Pennsylvanian (Desmoinesian & lower) Mississippian & basal Penn. unc.

Noncombustible gases include nitrogen (N₂), argon (Ar), carbon dioxide (CO₂), and helium (He). N₂ is the dominant noncombustible gas in Kansas natural gas



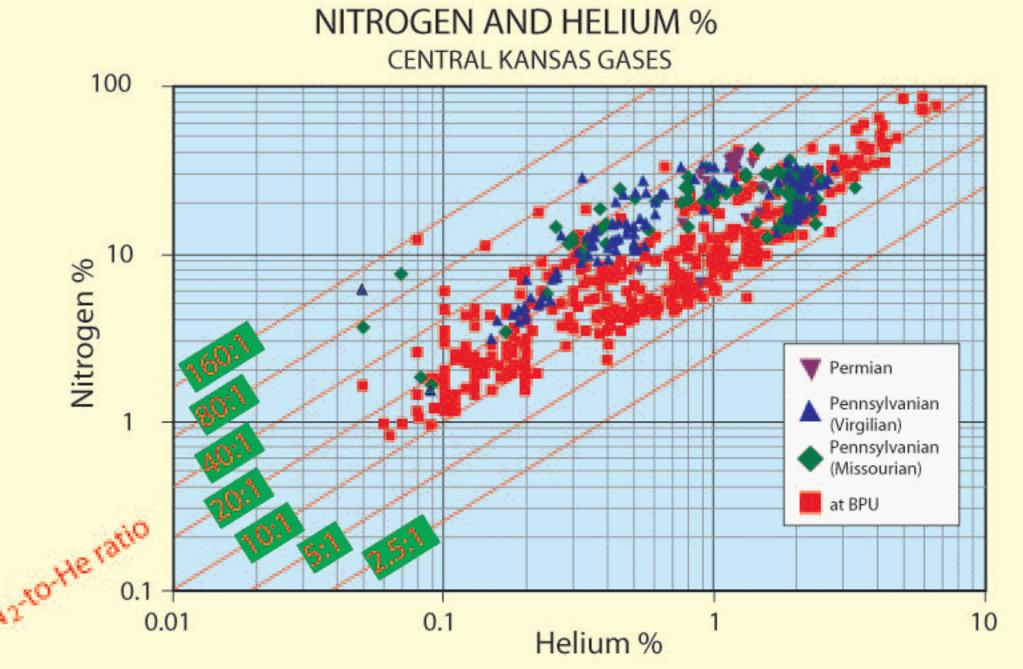
% NONCOMBUSTIBLE GASES COMPARED to AGE of RESERVOIR Permian gases contain the most noncombustible gas. Noncombustible gases decrease with increasing age of the reservoir.



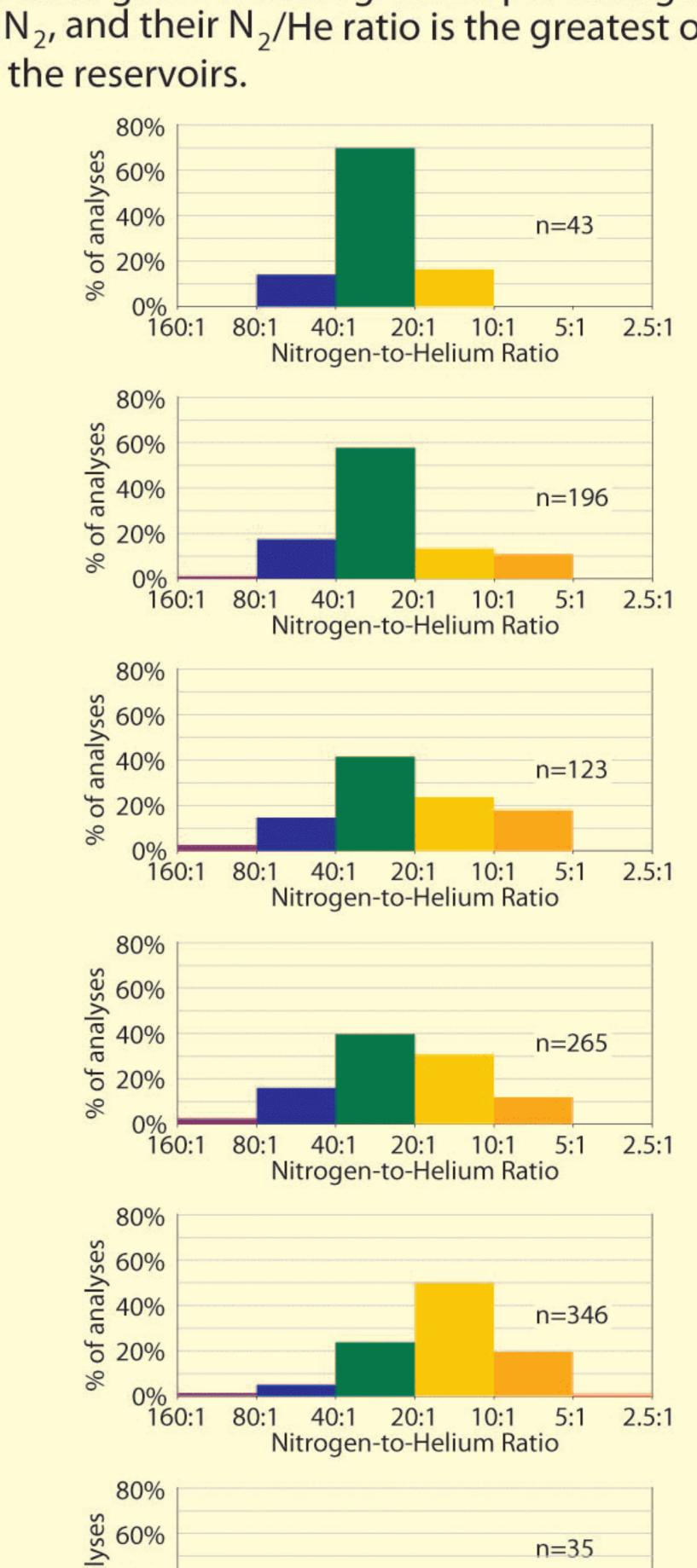
0% 10% 20% 30%

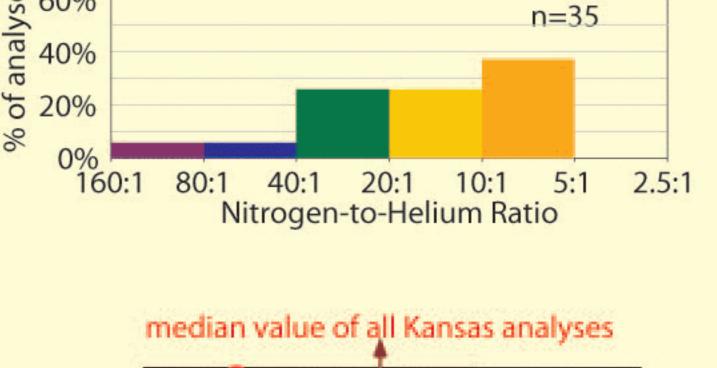
average % noncombustible gases

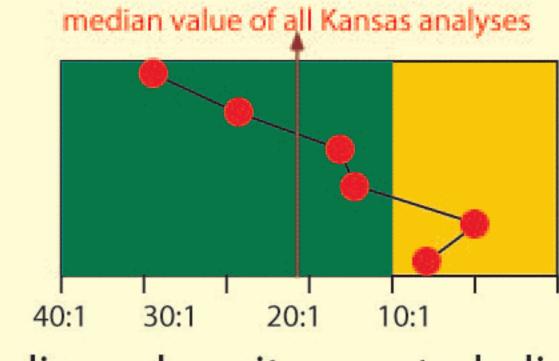
Helium (He) can be a salable commodity in Midcontinent gas. It is characteristically in a constant ratio with nitrogen in a given reservoir (Jenden and others, 1988).



NITROGEN-TO-HELIUM RATIO COMPARED to AGE of RESERVOIR Permian gases contain greatest percentages of N₂, and their N₂/He ratio is the greatest of all the reservoirs.







median value nitrogen-to-helium ratio

Pennsylvanian (Desmoinesian & lower)

Mississippian & basal Penn. unc.

sub-Mississippian