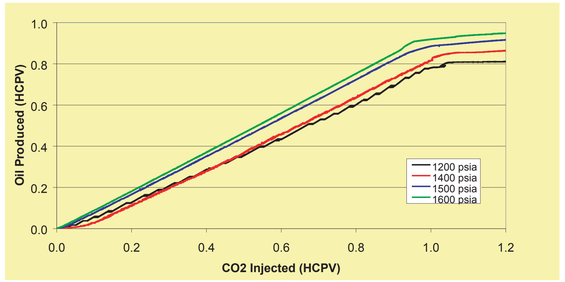
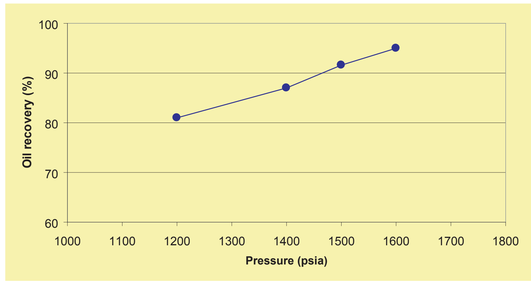
MINIMUM MISCIBILITY PRESSURE TEST

A minimum miscibility pressure (MMP) test was performed on an Ohio oil sample from the Copper Ridge sandstone in Wayne County, Ohio (APINO 3416925035). Jyun-Syung Tsau at the University of Kansas TORP laboratory, using slim-tube analyses, conducted this work.



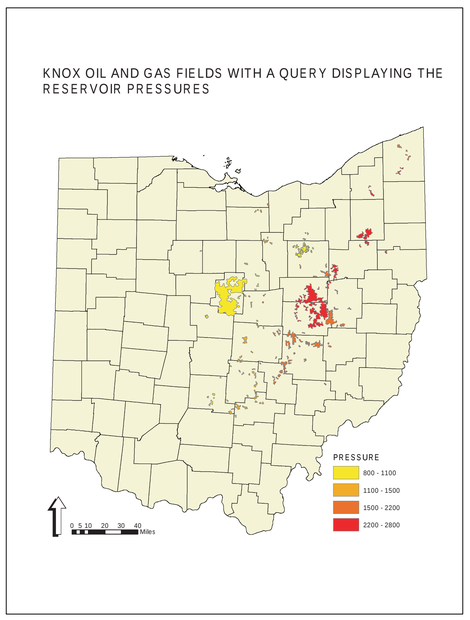
Oil recovery results in slim-tube experiment with CO_2 displacing Ohio oil sample at 107 °F.



This figure presents the oil recovery at 1.2 HCPV (hydrocarbon pore volume) of CO_2 injection as a function of pressure. The MMP is about 1500 psia, based on the trend line and the definition of reaching 90% recovery at 1.2 HCPV of CO_2 injection.

Physical properties of Ohio oil sample
Wayne County, OH
Red Bird Producing Co.
#2 Gasser
Permit No. 5035

Oil Sample	Viscosity (cp)		Density (g/cc)		API
	77 °F	107 °F	77 °F	107 °F	60 °F
Unfiltered	5.69	3.33	0.8113	0.7998	41.22
Filtered	4.83	3.20	0.8111	0.7997	41.21



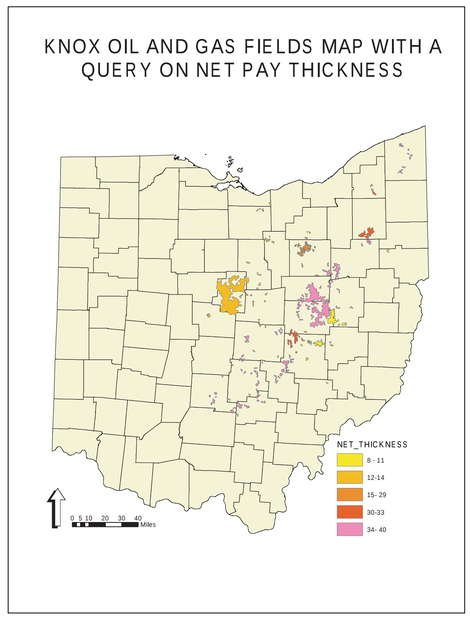


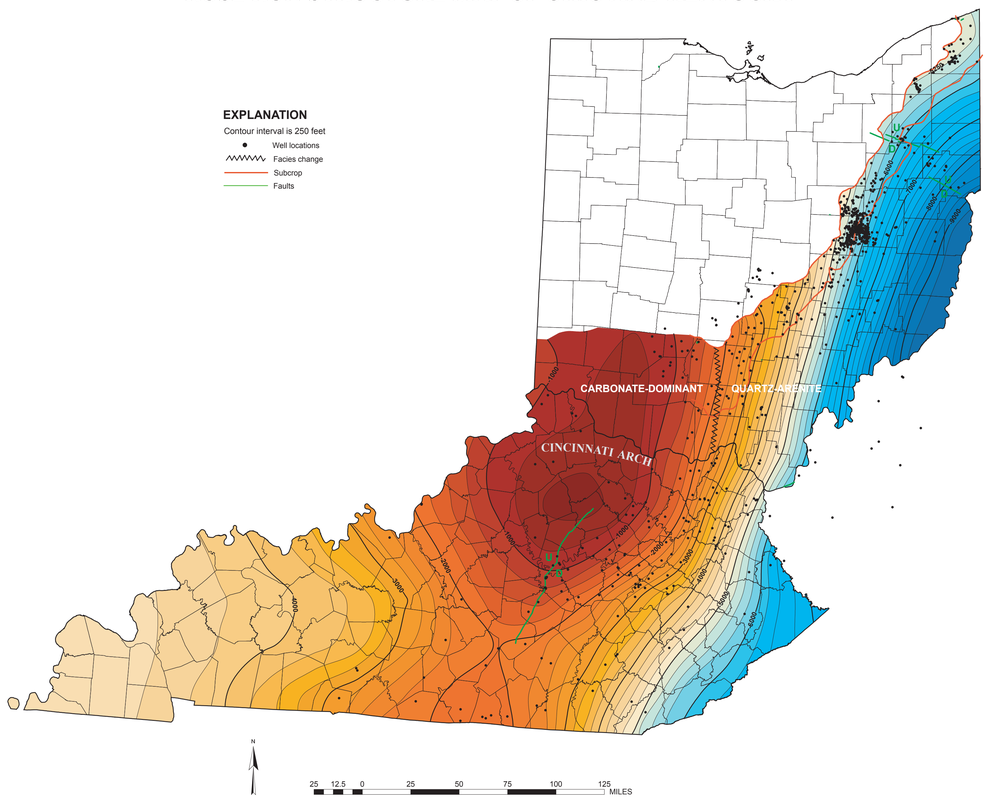
TABLE OF KNOX OIL AND GAS FIELDS WITH AVERAGE RESERVOIR CHARACTERISTICS AND CALCULATED CO_2 SEQUESTRATION VOLUMES.

FIELDID	FMTN	FIELD_NAME	DEPTH	THICK	TEMP	PRESS	POR	DISC	SW	RES_ACRE	No._POOLS	CO2_DENS	CO2_SEQ_VOL	PROD
537	CPRG	UTICA	4300	14	100	1500	0.06	1965	50	2139	4	1,867,417	762,568	OIL
870	RSRN	PINKERINGTON	3250	16	80	1100	0.07	1920	19	311	1	2,009,858	257,754	OIL
934	CPRG	BELLVILLE	4450	8	90	1100	0.09	1963	50	1161	2	1,288,505	244,792	OIL
944	CPRG	COLLINS	3750	12	100	1500	0.09	1966	50	1471	3	1,867,417	674,256	OIL
948	RSRN	BALTIC	6390	40	130	2500	0.10	1965	20	100505	12	1,938,856	277,770,747	GAS
953	KRSK	BIRMINGHAM-ERIE	3850	14	90	1700	0.15	1966	35	773	1	2,137,489	1,004,661	OIL
967	BKMN	BAKERSVILLE	7050	10	130	2200	0.15	1980	20	19977	3	1,805,998	19,679,135	GAS
969	RSRN	RANDOLPH	7095	30	140	2400	0.08	1990	30	16553	2	1,776,377	22,454,242	GAS
970	CPRG	DELAWARE	2511	13	80	900	0.09	1964	50	1731	1	542,758	249,825	OIL
974	CPRG	MORROW CONS	3600	14	90	900	0.08	1959	22	139635	2	480,467	26,640,822	OIL
977	RSRN	WELSHFIELD	6550	30	120	2300	0.07	1985	30	2820	2	1,980,238	3,944,525	GAS
978	RSRN	NEW LYME	6625	34	120	2300	0.09	1982	30	2215	2	1,980,238	4,270,589	GAS
986	CPRG	ONTARIO	4075	8	90	1400	0.11	1968	27	1007	1	2,002,889	588,937	OIL
994	RSRN	BEACH CITY	6675	40	120	2300	0.08	1990	30	10464	2	1,980,238	21,097,955	GAS
1289	CPRG	MUD LAKE	4402	13	90	1500	0.09	1964	50	3293	3	2,056,468	1,800,722	OIL
1291	CPRG	CAMEL CREEK	5269	13	100	1800	0.09	1990	50	552	1	2,040,786	299,550	OIL
1292	CPRG	CANAAN-WAYNE	5650	16	100	1100	0.09	1960	20	19490	8	691,733	6,824,279	GAS
1293	CPRG	SPLINTERVILLE	4125	12	100	1300	0.05	1965	37	1060	1	1,569,031	285,763	OIL
1294	CPRG	LUCAS	4350	11	90	1000	0.09	1963	50	1099	1	622,037	153,814	OIL
1357	CPRG	DOWD CREEK	5426	13	100	1900	0.09	1961	50	1170	2	2,079,554	646,978	OIL
1359	RSRN	LAKE OTTO	4963	35	100	1700	0.08	1997	50	2890	3	1,995,048	3,669,075	GAS
1360	RSRN	KIRKERSVILLE	3715	35	90	1300	0.08	1992	50	2613	3	1,931,886	3,212,375	OIL
1367	RSRN	LODELL CREEK	3919	35	90	1300	0.08	1993	50	3953	1	1,931,886	4,859,747	OIL
1369	BKMN	BRANNONS FORK	7469	10	110	2600	0.15	1983	50	501	1	2,172,337	371,025	GAS
1371	CPRG	FREDERICKTOWN	4045	12	100	1400	0.09	1963	50	1001	2	1,763,309	433,245	OIL
1373	RSRN	BEAVER RUN	4132	35	90	1400	0.08	1965	50	422	1	2,002,889	537,867	GAS
1374	RSRN	GRIGGS CORNERS	5808	35	100	2000	0.08	1995	50	403	1	2,113,967	542,136	GAS
1375	CPRG	BURNETTS CORNERS	5492	13	100	1900	0.09	1996	50	815	1	2,079,554	450,673	OIL
1376	CPRG	WESTFIELD CENTER	5427	13	100	1900	0.09	1993	50	632	2	2,079,554	349,479	GAS
1377	RSRN	MUNSON HILL	5494	35	100	1900	0.08	1999	50	1613	1	2,079,554	2,134,568	GAS
1378	RSRN	DORSET	6011	35	100	2100	0.08	1990	50	1687	2	2,144,459	2,302,174	GAS
1379	RSRN	WALBORN RESERVOIR	7394	35	110	2500	0.08	1996	50	2706	1	2,148,379	3,699,509	GAS
1380	RSRN	NIMISHILLEN CREEK	7233	35	110	2500	0.08	1994	50	581	1	2,148,379	794,314	GAS
1382	BKMN	WESTVILLE LAKE	8062	10	120	2800	0.15	1991	50	952	1	2,127,470	690,461	GAS
1384	RSRN	MOUNT EATON	6401	35	110	2200	0.08	1990	50	5809	3	2,062,130	7,622,946	GAS
1385	CPRG	MEADOW LAKE	6192	13	100	2100	0.09	1990	50	622	1	2,144,459	354,684	GAS
1386	RSRN	WALNUT CREEK	6608	35	110	2300	0.08	1988	50	4246	4	2,093,494	5,656,620	GAS
1387	BKMN	ANGEL VALLEY	7094	10	110	2400	0.15	1991	50	955	1	2,122,243	690,935	GAS
1388	BKMN	SHARON VALLEY	7452	10	110	2600	0.15	1991	50	637	1	2,172,337	471,743	GAS
1390	RSRN	FRAZEYBURG	5825	30	100	2000	0.08	1989	30	16901	6	2,113,967	27,283,317	GAS
1391	BKMN	BLOOMFIELD	6485	10	110	2200	0.15	1991	50	11246	7	2,062,130	7,905,927	GAS
1392	BKMN	PLEASANT GROVE	6040	10	100	2100	0.15	1994	50	967	1	2,144,459	706,940	GAS
1393	RSRN	RUSH CREEK	5327	35	100	1800	0.08	1988	50	13307	12	2,040,786	17,281,561	GAS
1394	RSRN	LICK RUN	2490	35	80	900	0.08	1993	50	3224	5	542,758	1,113,541	OIL
1395	RSRN	DUMM RIDGE	3650	35	90	1300	0.08	1992	50	7572	6	1,931,886	9,308,881	GAS
1396	RSRN	BALTIMORE	4032	35	90	1400	0.08	1993	50	4143	7	2,002,889	5,280,525	OIL
1397	RSRN	ROCKBRIDGE	4334	35	90	1500	0.08	1993	50	4747	6	2,056,468	6,212,215	GAS
1398	RSRN	SLATE RUN	2710	35	80	900	0.08	1994	50	320	1	542,758	110,525	OIL
1399	CPRG	SPRING BRANCH	2364	13	80	800	0.09	1984	50	422	1	416,434	46,730	OIL
1401	RSRN	COLFAX	4219	35	90	500	0.08	1995	50	1615	1	2,056,468	2,113,488	OIL

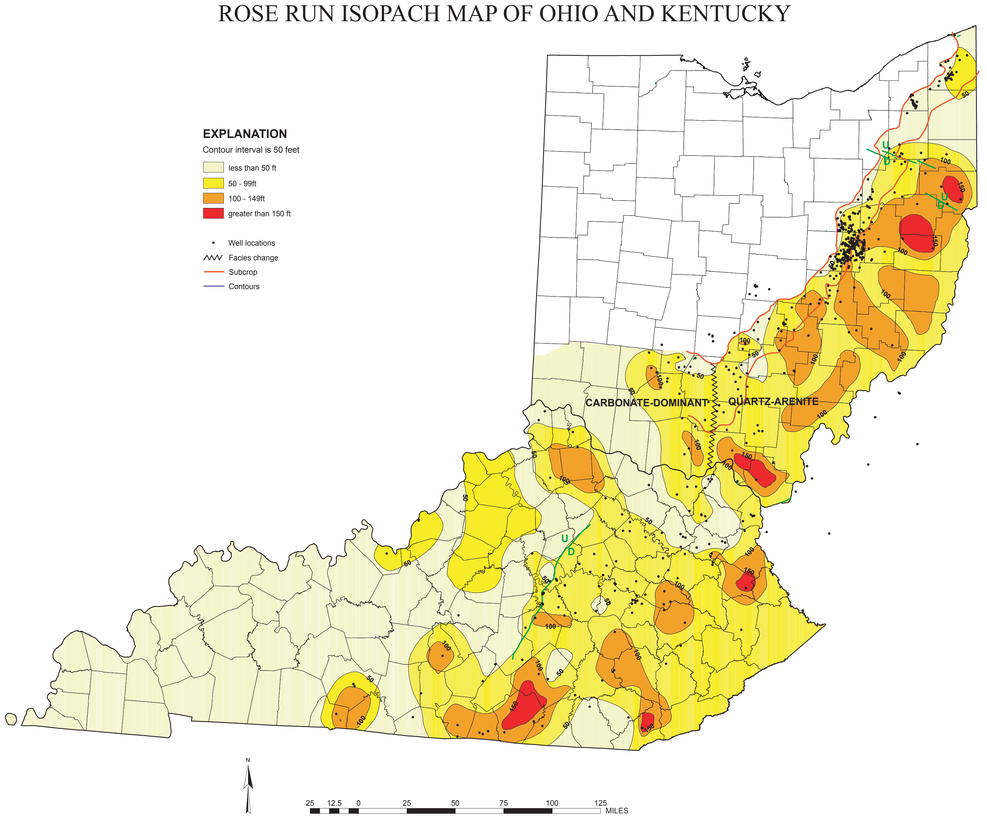
ROSE RUN STRUCTURE AND ISOPACH MAP OF OHIO AND KENTUCKY

Compiled by:
Riley, R. A., Baranoski, M. T., Hickman, J. B., Powers, D. M.

ROSE RUN STRUCTURE MAP OF OHIO AND KENTUCKY



ROSE RUN ISOPACH MAP OF OHIO AND KENTUCKY



Structure and Isopach Mapping of the Cambrian-Ordovician Rose Run Sandstone in Ohio and Kentucky--Basic Tools for Characterization of Hydrocarbon Reservoirs for CO_2 Sequestration

The Rose Run sandstone, a unit of the Knox Dolomite, is laterally persistent throughout the mapped area, except where it terminates along the northeast-southwest trending subcrop. This subcrop trend developed from the westward truncation of Knox units along the regional Knox unconformity. A facies change occurs where the quartz arenite-dominated Rose Run changes to a carbonate-dominated unit in southern Ohio on the west flank of the Waverly Arch. The quartz arenite-dominated Rose Run, stratigraphically below the Beekmantown dolomite, also extends southward into Kentucky.

Deposition of the Knox interval occurred on a broad platform of low relief that was subjected to periodic sea level changes, which resulted in a mixed siliciclastic-carbonate sequence. Lithologically, the Rose Run interval consists of a stacked sequence of up to five sandstone units interbedded with thin, low-permeability dolomite and carbonaceous shale. In the mapped area, the subsea depth to the Rose Run interval ranges from -500 to -9,250 feet. The gross thickness typically ranges from 50 to 150 feet and averages 100 feet.

In the absence of open fractures or faults, an effective confinement zone is present above the Rose Run sandstone for CO_2 sequestration. The immediate confining units for the Rose Run sandstone consist of the overlying Ordovician Beekmantown dolomite, the Wells Creek Formation, the Black River Group and the Trenton/Lexington Limestone. In Ohio, these units can attain a total thickness up to 1,500 feet, depending on the location in the Appalachian basin and proximity to the subcrop. Between the top of the immediate confining units (Trenton/Lexington Limestone) and the base of the lowermost Underground Source of Drinking Water (Mississippian-Pennsylvanian), these overlying rocks have an additional thickness up to 4,000 feet.

The Rose Run is an excellent candidate for CO_2 sequestration based upon its reservoir characteristics. These include high porosities (average 9 percent) and permeabilities (average 5 md) (Baranoski and others, 1996), adequate thickness, lateral continuity over regional areas, and its occurrence at depth with thousands of feet of overlying sequences of carbonates, shales, and sandstones. These good reservoir qualities have made this interval an important hydrocarbon-producing unit in eastern and central Ohio, and one of the most active exploratory plays in the Appalachian basin. Thus, Rose Run oil and gas fields also have potential for value-added sequestration through CO_2 injection.

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