BRIEF REPORT ON THE

COTTON VALLEY LIME (GILMER LIMESTONE) OF NORTHEAST TEXAS

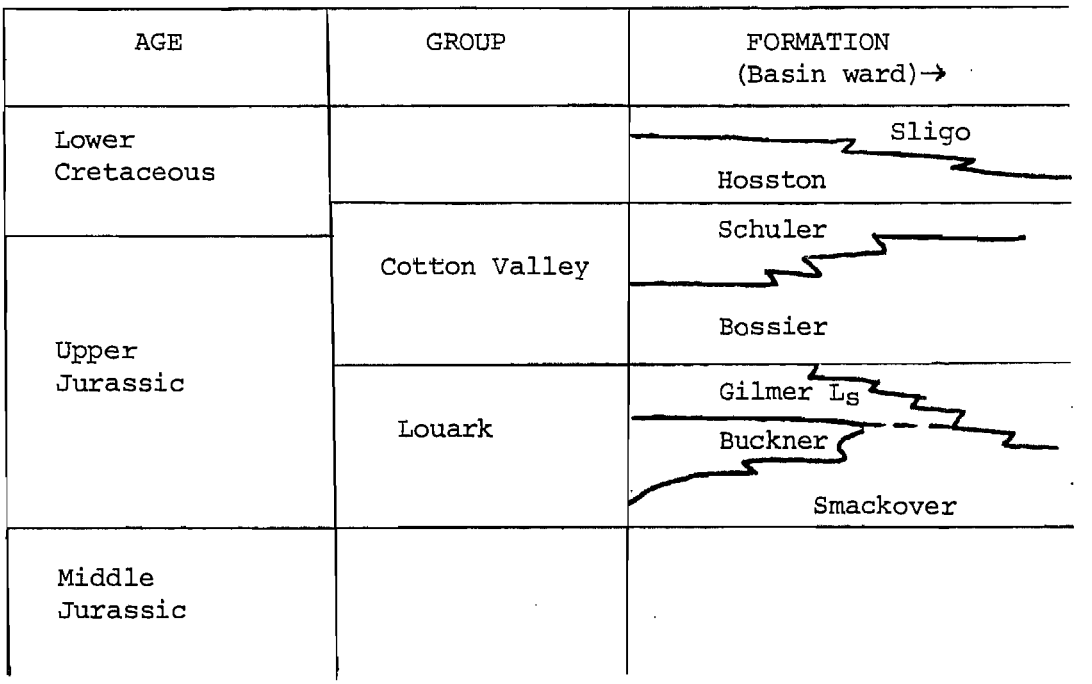
BY

LANCE T. HODGES

1. DEFINITION

The Cotton Valley Limestone, Cotton Valley Lime, and Haynesville Limestone are informal terms which have been replaced by the formal Gilmer Limestone Formation of Upper Jurassic age (Forgotson and Forgotson, 1976). The Gilmer Limestone is separated from the overlying Cotton Valley Group by a major unconformity and is not included in that group. The Gilmer Limestone overlies either the Buckner Formation or the Smackover Formation.

2. STRATIGRAPHY AND EXTENT



The above figure illustrates the position of the Gilmer Limestone relative to other Upper Jurassic Formations in the northeast Texas -- northwest Louisiana -- southwest Arkansas area (Forgotson and Forgotson, 1976). The Gilmer Limestone is stratigraphically equivalent to the Haynesville Formation which was defined as a predominantly red sandstone and shale unit, so that use of the term Haynesville Limestone should be discontinued.

Earlier, Swain (1944, p. 592) did not recognize any rock units between the Bossier Formation and the Buckner Formation or even a disconformity between them.

The areal extent of the Gilmer Limestone is not well known. It is stratigraphically equivalent to and replaced by the Haynesville Formation near the Texas-Louisiana-Arkansas border. It grades into sandstone and shale of the Haynesville Formation towards the west, north, and northeast. Where the Gilmer Limestone lies directly on the Smackover, these units are difficult to separate. In this case the Louark Group is a satisfactory name.

Confusion about boundaries between the Cotton Valley Group and underlying units such as the Smackover Formation exists because they are difficult to distinguish in the subsurface, and in the past, some geologists placed part or all of the Smackover limestones in the Cotton Valley Group (Swain, 1949, p. 1217). This may be the origin of the informal "Cotton Valley Lime." A schematic stratigraphic cross-section of the Cotton Valley Smackover is shown in Figure 1.

The Buckner Formation, where it underlies the Gilmer Limestone is usually recognized by its anhydrite and shaly facies, and this, then separates the Gilmer from underlying carbonate units.

The Gilmer Limestone does not outcrop, but is known only in the subsurface. The type well (Forgotson and Forgotson, 1976) is Indiana Rock Gas Unit 2 of the Arkansas Louisiana Gas Company. It is located in the Gilmer Field, 3 miles east of Gilmer, Upshur County, Texas. The elevation of the well is 418 ft (KB). The top of the Gilmer Limestone is at 11,620 ft depth, and the base (top of Smackover Formation) at 11,940 ft depth, giving a thickness of 320 ft at the type well.

Swain (1949, p. 211) has drawn a structure contour map for the pre-Cotton Valley Jurassic in northeastern Texas. Depths to the (assumed) surface of the Gilmer Limestone or its Haynesville equivalent appear to range

from about 4,000 ft to more than 12,000 ft. The surface dips to the southeast. In Limestone County, of interest because of Mitchell Energy's MHF well, depths to the Gilmer Limestone range from less than 5,000 ft to over 12,000 ft.

3. PRODUCTION - REGIONAL

The Cotton Valley Group above the Gilmer Limestone did not have significant production of oil or gas in Texas, Mississippi or Alabama up to 1954 (Forgotson, 1954). Minor amounts have been produced in southern Arkansas. The major production in the Cotton Valley Group before 1954 was from the Schuler Formation in northern Louisiana, where marine sands yielded oil and gas distillate.

In 1976 (Vineyard and others, 1977) exploration in Arkansas-Louisiana-east Texas increased significantly over 1975. In south Arkansas, the Smackover Formation was most actively explored. Oil and gas were produced from Cretaceous through Jurassic formations in south Arkansas.

Gas in the Cotton Valley Group was one of the main objectives in north Louisiana in 1976. There was minor activity in the Smackover Formation.

Gas exploration was important in east Texas in 1976. The Cotton Valley Group was probably the most important objective. Some activity was continued in the Smackover Formation. Jurassic carbonate development (includes the Gilmer Limestone) was important in the Freestone-Limestone County area. Continued activity for gas in the tight sands of the Travis Peak and Cotton Valley units, and in the tight Jurassic carbonates was projected for 1977 (Vineyard and others, 1977).

A 1978 article in World Oil (Collins, 1978) states that previously uneconomic gas reservoirs in the Cotton Valley and Smackover rock units are made economic by hydraulic fracturing. Large reserves of gas are present in these

low porosity (7 - 10%) and low permeability (less than 0.5 md) sands and limes. However, little is known of the sparsely drilled downdip (deeper) portions of the rock units. The distribution of Cotton Valley reservoirs are shown in Figure 2, while Figure 3 illustrates Smackover reservoirs (Collins, 1978).

The Cotton Valley sands of interest for gas are of two types: low porosity and permeability, massive undifferentiated sands, and porous, permeable blanket-strand line sands.

The low permeability massive sands may be productive over the entire Sabine uplift area; Carthage, Washam, Elm Grove, and Caspiana are some of the productive fields. In the Sabine uplift, pay totals vary from 50 - 200+ ft. Multiple staged sand fracs are necessary to obtain flows exceeding 1 MMCFD. Frac treatments in the massive sands vary from 10,000 lb of sand in a single stage job to 1,000,000 lbs of sand in a massive, staged job. Reserve estimates are speculative (Collins, 1978). Collins of Dallas Exploration (personal communication) did not think massive fracs were too successful in the Cotton Valley generally. This is difficult to understand considering the activity in the area.

Bain, Superintendent, Amoco Production, Tyler, Texas, says that Amoco has done about 15 MHF treatments in the Cotton Valley Group sands (about 1,500 ft total section). He mentioned that a frac job on a well with 100 MCFD production before fracing is a good well if production is 1.5 - 2 MMCFD after fracing. Amoco has used the services of Halliburton, Dowell, Western, and B.J. Hughes in their frac jobs in northeast Texas.

Bill Tindell of Halliburton says Halliburton has done a 1.6 million lb sand frac for Amoco in the Cotton Valley sands. He says they are planning a 2.6 million lb sand frac for Amoco for the end of August, 1978. Tindell says Amoco has already done 15-20 fracs with over 1 million lb of sand each in the Cotton Valley sands, most of these in the Woodlawn Field in

Harrison County, Texas. Fracs have been done in nearby counties by other operators. The sands there are a little more permeable than in Harrison County, according to Tindell.

Jennings and Sprawls (1977) discuss hydraulic fracturing in the Cotton Valley sandstone. They claim success with moderately viscous, temperature-stable aqueous gel systems. Production after fracturing ranges from two to ten times prefrac production. Jennings and Sprawls give fracture treatment data for wells in the Bethany, Elmgrove, Dorcheat-Macedonia, Frierson, Waskom, and other fields of the Cotton Valley sandstones.

4. PRODUCTION - GILMER (COTTON VALLEY) LIMESTONE

The Gilmer (Cotton Valley) Limestone of east Texas is thick, massive, oolitic, and finely crystalline. It rims part of the east Texas basin and the Sabine uplift. The clean, porous, oolitic zones of the top 300 ft are being actively explored (Collins, 1978). Teague Field, Freestone County, Texas is producing more than 30 MMCFD from 9 Gilmer Limestone wells. Exxon is developing its giant Overton Field on the west flank of the Sabine uplift. Potential reserves of up to 1 TCF have been reported for this area. Gilmer Field in Upshur County, Texas has produced 50 BCF. Stratigraphy is more important than structure for gas production here.

Gilmer Limestone reserves vary considerably from well to well, since porosity variations range from 4 - 17% and the results of fracturing are unpredictable. Most wells probably will recover in the 2 - 5 BCF range. Drainage area of the wells is an unknown factor (Collins, 1978).

Fractures aid significantly in well production. For example, wells with 6% or less porosity and permeability less than 0.4 md can sustain a 500 MCFD flow rate after fracing. Internal fracturing or porosity greater than 7% is usually needed for a 1 MMCFD flow rate.

Calcite cement in pore spaces is an important but unpredictable variable affecting porosity. This affects reserves and flow rates (Collins, 1978).

According to Halliburton Services, Dallas (Ayers, personal communication), about 75 wells have been completed in the Cotton Valley Lime of east Texas. Information on most of these wells is proprietary. Stimulation by acidizing in the tight reservoirs of east Texas has not generally been very effective. Successfully acidized wells would probably have been good wells anyway with only good damage removal treatment.

One of the major problems in using frac fluid in east Texas carbonate reservoirs was the reduction in viscosity of the frac fluid because of high temperature in the reservoirs (300^{o}F and higher). This was a problem until introduction of frac fluids such as Hygel and Versagel. Prior to January 1976, only about two dozen frac jobs had been performed in the various carbonate reservoirs in east Texas. With an improved proppant (sintered bauxite), first used in January 1976, more than 50 Cotton Valley Lime frac jobs have been performed to date. More than a dozen Cotton Valley Lime wells have produced at a rate higher than 3 MMCFD for more than 6 months (Ayers, personal communication).

According to Harry Horton (Engineer at Dowell), Dowell has performed massive fracs on five wells in the Cotton Valley Limestone in Freestone County, Texas. He says production rate before frac treatment on these wells was low, less than 100 MCFD. Production rates after fracing vary from 1 MMCFD to 5 MMCFD for these wells (operator names were not released).

REFERENCES

Collins, S.E., 1978, Jurassic Exploration Still Strong in the Ark-La-Tex area: World Oil, May, p. 61-66.

Forgotson, J.M., Jr., 1954, Regional Stratigraphic Analysis of Cotton Valley Group of Upper Gulf Coastal Plain: American Association Petroleum Geologists Bulletin, V. 38, p. 2476 - 2499.

Forgotson, J.M., and Forgotson, J.M., Jr., 1976, Definition of Gilmer Limestone, Upper Jurassic Formation, northeastern Texas: American Association Petroleum Geologists Bulletin, V. 60, p. 1119 - 1123.

Jennings, A.R., Jr., and Sprawls, B.T., 1977, Successful Stimulation in the Cotton Valley Sandstone - A Low Permeability Reservoir: Journal of Petroleum Technology, October, p. 1267 - 1276.

Swain, F.M., 1944, Stratigraphy of Cotton Valley Beds of Northern Gulf Coastal Plain: American Association Petroleum Geologists Bulletin, V. 28, p. 577 - 614.

_____, 1949, Upper Jurassic of Northeastern Texas: American Association Petroleum Geologists Bulletin, V. 33, p. 1206 - 1250.

Vineyard, J.W., and others, 1977, Developments in Arkansas, Louisiana, and East Texas in 1976: American Association Petroleum Geologists Bulletin, V. 61, p. 1234 - 1243.