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Enhanced oil recovery with carbon dioxide flooding in New Mexico

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Carbon dioxide (CO_2) gas may be injected into oil reservoirs to recover oil that cannot be produced by primary production or conventional waterflood techniques. Carbon dioxide injection is usually begun after oil production with waterflood techniques wanes and is no longer economically attractive. The CO_2 is soluble in crude oil at reservoir pressures and when injected into the reservoir allows production of oil not recoverable by conventional methods, chiefly by becoming miscible with the oil and allowing it to flow more easily through the reservoir. Only approximately 26% of the original oil in place in New Mexico reservoirs is recoverable by primary and waterflood operations (Foster, 1980, p. 58). It is estimated that 622 million bbls of oil are recoverable by using CO_2 flooding of reservoirs in the Permian Basin of southeast New Mexico (Foster, 1980, p. 68). Currently, full-scale CO_2 flooding operations have begun in several oil fields in the west Texas part of the Permian Basin (Fig. 1). In New Mexico, pilot flooding has been conducted at the Maljamar field and will commence in the near future at the Loco Hills field (Fig. 1). Full-scale CO_2 flooding will commence in southeast New Mexico after existing waterflood operations are no longer economically feasible.

Taber and Martin (1983) have given technical screening guides that may be used to select oil fields that are favorable to CO_2 flooding, rather than other enhanced-recovery methods such as steamflooding, fireflooding, or surfactant flooding. Briefly, the screening guides for CO_2 flooding place the following physical and chemical constraints on the oil and the reservoir rock: 1) oil gravity should be more than 26 degrees API; 2) oil viscosity should be less than 15 centipoise; 3) a large percentage of oil hydrocarbons should be in the C_5–C_{12} range; 4) oil saturation should be more than 30% of pore volume; 5) the reservoir may be either a sandstone or a carbonate rock; 6) the reservoir should be fairly thin unless the reservoir stratum is steeply dipping; 7) reservoir permeability need be only high enough to maintain sufficient injection rates suitable for oil production; 8) depth of the reservoir should be more than 2,000 ft in order to obtain a reservoir pressure that is high enough for optimum production.

The principal sources of CO_2 for use in enhanced-oil-recovery operations in the Permian Basin of southeast New Mexico and west Texas will be three natural CO_2 accumulations in northeast New Mexico and southern Colorado (Fig. 1). The Bravo dome of Union and Harding Counties, New Mexico, has estimated reserves of 10 TCF (trillion ft^3) of 98% pure CO_2 (Smith, 1984). McElmo dome and other structures in southwest Colorado have estimated reserves of 10 TCF of 95% pure CO_2 (Wash, 1984). The Sheep Mountain field of southeast Colorado has estimated reserves of 1–1.5 TCF of 96% pure CO_2 (Crouse, 1981).

Three pipelines will transport CO_2 from the three sources to the Permian Basin (Fig. 1). The Bravo pipeline will transport CO_2 from the Bravo dome at a maximum capacity of 700 MMCFGPD (million ft^3 gas per day; Smith, 1984); the Bravo pipeline was scheduled to be completed in November, 1984 (Oil and Gas Journal, 1984). The Sheep Mountain pipeline has been completed and will transport CO_2 from Sheep Mountain and Bravo dome to the Permian Basin; capacity is 330 MMCFGPD from Sheep Mountain and an additional 170 MMCFGPD from Bravo dome (Oil and Gas Journal, 1982). The Cortez pipeline has been completed and will transport CO_2 from McElmo dome to the Permian Basin at a maximum capacity of 1 BCFGPD (billion ft^3 gas per day; Wash, 1984).

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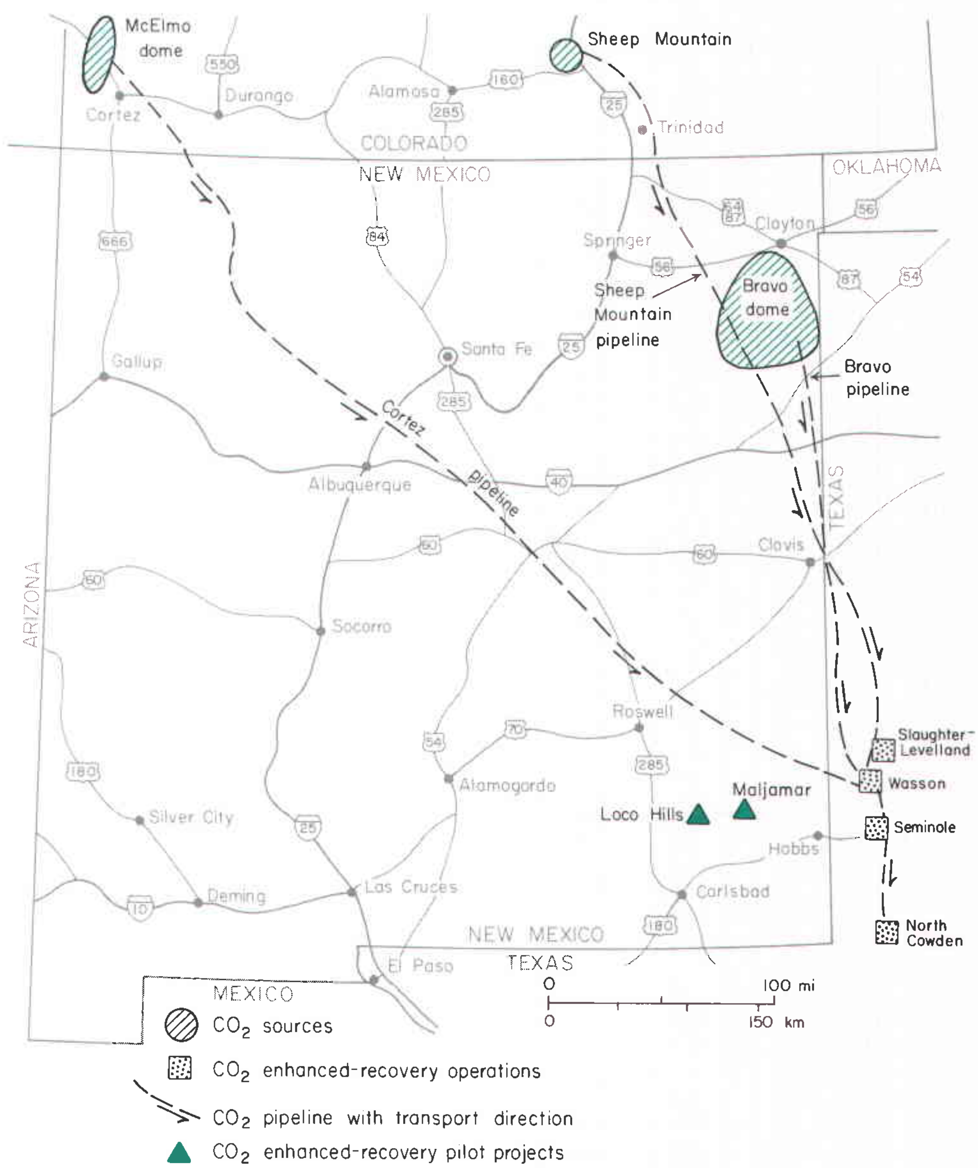

FIGURE 1—Carbon dioxide sources and enhanced-recovery operations in New Mexico and adjoining parts of Colorado and Texas; modified from Foster (1980, fig. 7).