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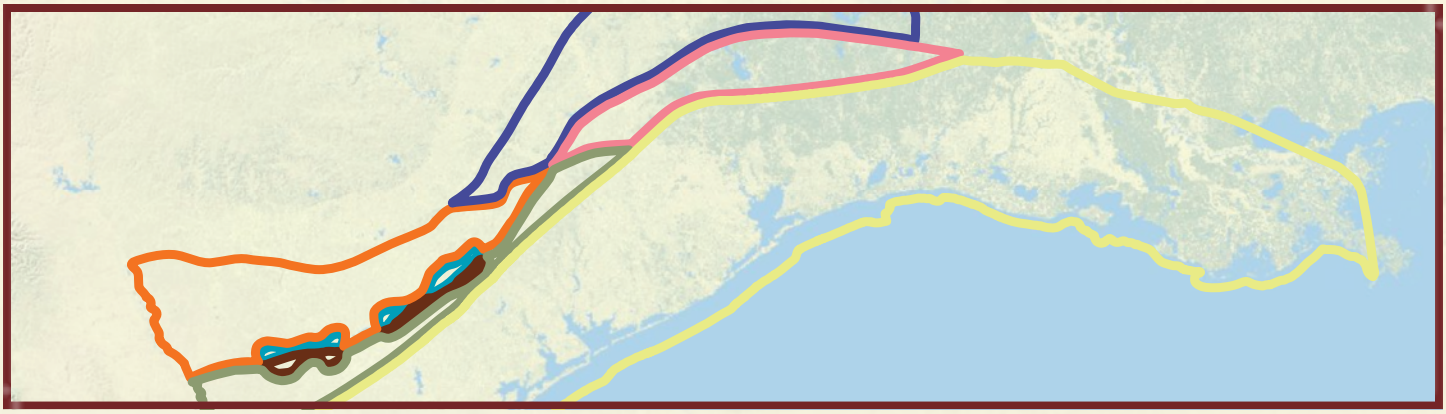
Steps Taken for Calculating Estimated Ultimate Recoveries of Wells in the Eagle Ford Group and Associated Cenomanian–Turonian Strata, U.S. Gulf Coast, Texas, 2018



Scientific Investigations Report 2020–5077

U.S. Department of the Interior
U.S. Geological Survey

Cover. Western Texas with assessment unit boundaries for the Eagle Ford Group and associated Cenomanian-Turonian strata of the U.S. Gulf Coast in Texas (figure 1 of this report).

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U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2020

Suggested citation:
Leathers-Miller, H.M., 2020, Steps taken for calculating estimated ultimate recoveries of wells in the Eagle Ford Group and associated Cenomanian–Turonian strata, U.S. Gulf Coast, Texas, 2018: U.S. Geological Survey Scientific Investigations Report 2020–5077, 5 p., https://doi.org/10.3133/sir20205077.

ISSN 2328-0328 (online)

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
Volume		
barrel (bbl; petroleum, 1 barrel=42 gal)	0.1590	cubic meter (m^3)
cubic foot (ft^3)	28.32	cubic decimeter (dm^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)

Abbreviations

AU	assessment unit
EUR	estimated ultimate recovery
MBO	thousand barrels of oil
MMcf	million cubic feet of gas
USGS	U.S. Geological Survey

Steps Taken for Calculating Estimated Ultimate Recoveries of Wells in the Eagle Ford Group and Associated Cenomanian–Turonian Strata, U.S. Gulf Coast, Texas, 2018

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Abstract

In 2018, the U.S. Geological Survey published an assessment of technically recoverable continuous oil and gas resources of the Eagle Ford Group and associated Cenomanian–Turonian strata in the U.S. Gulf Coast of Texas. Estimated ultimate recoveries (EURs) were calculated with production data from IHS Markit™ using DeclinePlus software in the Harmony interface. These EURs were a major component of the aforementioned quantitative resource assessment fact sheet. The calculated mean EURs for each oil assessment unit (AU) ranged from 113,000 barrels of oil in the Cenomanian–Turonian Mudstone Continuous Oil AU to 223,000 barrels of oil in the Submarine Plateau-Karnes Trough Continuous Oil AU. The calculated mean EURs for each gas AU ranged from 2.261 billion cubic feet of gas in the Submarine Plateau-Karnes Trough Continuous Gas AU to 3.116 billion cubic feet of gas in the Eagle Ford Marl Continuous Gas AU.

Introduction

In 2018, the U.S. Geological Survey (USGS) completed an assessment of the technically recoverable, undiscovered continuous oil and gas resources of the Eagle Ford Group and associated Cenomanian–Turonian strata of the U.S. Gulf Coast in Texas (Whidden and others, 2018). Continuous resources for this assessment included shale oil and shale gas. The calculation of estimated ultimate recoveries (EURs) for oil and gas wells is a major component of the USGS assessment methodology for continuous resources (Charpentier and Cook, 2012). The assessment methodology includes inputs such as mean EUR, unit acreage, and future success ratio of drilled wells. This report focuses on the procedure used to calculate EURs that were subsequently used in the quantitative assessment. For the purposes of this report, the term EUR will refer to the individual estimated ultimate recovery of any given well. The range EURs will refer to all the individual EURs that are included in a given assessment unit (AU). Finally, the mean EUR will refer to the arithmetic average of the range EURs. EURs were calculated for wells in five of the seven AUs (fig. 1):

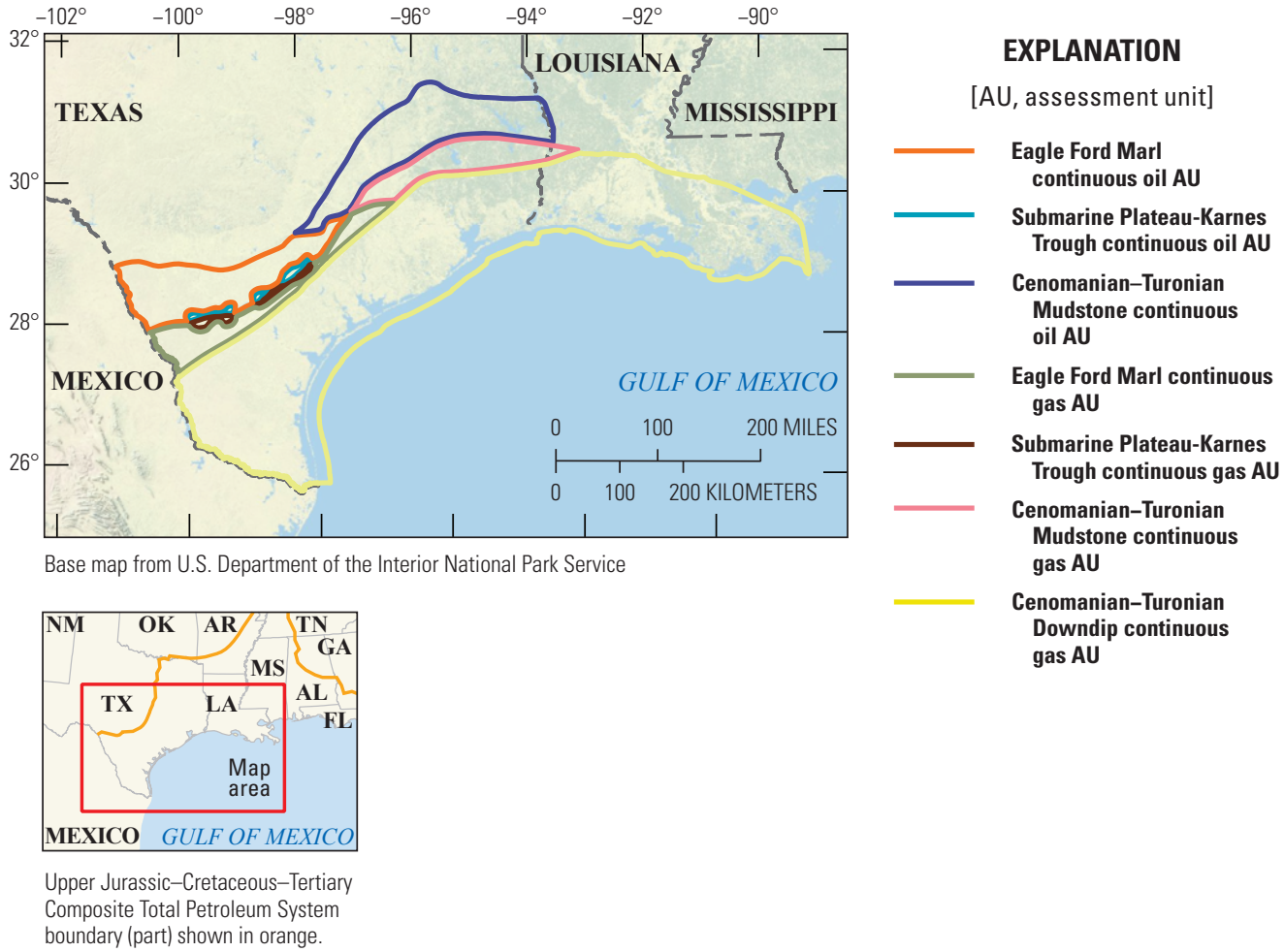
- Eagle Ford Marl Continuous Oil AU,
- Submarine Plateau-Karnes Trough Continuous Oil AU,
- Cenomanian–Turonian Mudstone Continuous Oil AU,
- Eagle Ford Marl Continuous Gas AU, and
- Submarine Plateau-Karnes Trough Continuous Gas AU.

Not enough wells or production data were available to calculate EURs for the Cenomanian–Turonian Mudstone Continuous Gas AU, and analog data were used for the quantitative assessment. The final AU, the Cenomanian–Turonian Downdip Continuous Gas AU, was not quantitatively assessed.

Steps Taken

A resource assessment was conducted for the Eagle Ford Group and associated Cenomanian–Turonian strata of the U.S. Gulf Coast in Texas, which have been a primary focus of exploration for continuous accumulations in the last decade or so. The lead geologist defined AU boundaries based on a variety of geologic criteria, such as thickness, lithology, and thermal maturity of source rocks (Whidden and others, 2018). Wells within the AUs were identified, and a map of the wells in each AU was created, yielding separate groups of wells for each AU.

Next, monthly production data were extracted from the IHS Markit™ database, which is current as of February 2018 (IHS Markit™, 2018). This is a proprietary database to which



Base map from U.S. Department of the Interior National Park Service

Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System boundary (part) shown in orange.

Figure 1. Western Texas with assessment unit boundaries for the Eagle Ford Group and associated Cenomanian–Turonian strata of the U.S. Gulf Coast in Texas (from Whidden and others, 2018).

the USGS subscribes. Along with the production data, other ancillary data, such as production start dates, were concurrently extracted to aid in organization and application of the final EURs.

EURs were calculated with decline curves using the IHS Markit™ DeclinePlus software, which is run on the Harmony interface (IHS Markit™, 2015). The DeclinePlus software is equipped to calculate decline curves using four different methods: (1) traditional decline (such as Arps), (2) multi-segment decline, (3) Duong, and (4) stretched exponential. For the assessment of continuous oil and gas resources, the USGS uses the stretched exponential method because it is considered a mathematical construct for use on continuous resources (Valkó, 2009). The stretched exponential method also is used because traditional Arps decline methods are based on flow and other assumptions that are commonly invalid for wells in continuous accumulations (Anderson and others, 2010). In addition, the multi-segment method is a simple extension of traditional decline, and Duong tends to give erratic results likely because of wells not meeting the method's slope requirements. These are observations based on working with the DeclinePlus software.

The EUR for each well was modeled on a 60-year timespan using 100 percent of the production data points available. Wells with less than 18 months of production were removed from the analysis because data from early production are commonly erratic and an accurate trend cannot be modeled for these early stage wells. This is an observation based on working with production and decline curves.

Any wells with EURs of less than 2,000 barrels of oil or less than 20,000 cubic feet of gas were also removed from the analysis. If a well is loaded into the DeclinePlus software with no production data, the software will calculate a fixed EUR value; this value is around 20 but varies based on the program settings. Wells with these fixed values were removed from the analysis. Finally, wells on the upper end of the range EURs were investigated, and any that had production profile shapes not suitable for production forecasting were removed. Such wells generally had profiles where the maximum monthly production takes place long after initial production or profiles with major spikes in production over time. The wells that were removed from the analysis for any of these reasons were considered nonproducers but were subsequently used in the success ratio part of the overall assessment rather than in consideration for the range EURs.

The procedure just outlined results in an EUR for each well and a range of EURs for each AU. The mean of each EUR range is critical and used in the assessment process. The mean EUR is used as an input for each AU in a Monte Carlo simulation for the resource assessment. The EUR ranges for the three oil AUs are shown in figure 2, and the EUR ranges for two of the four gas AUs are shown in figure 3.

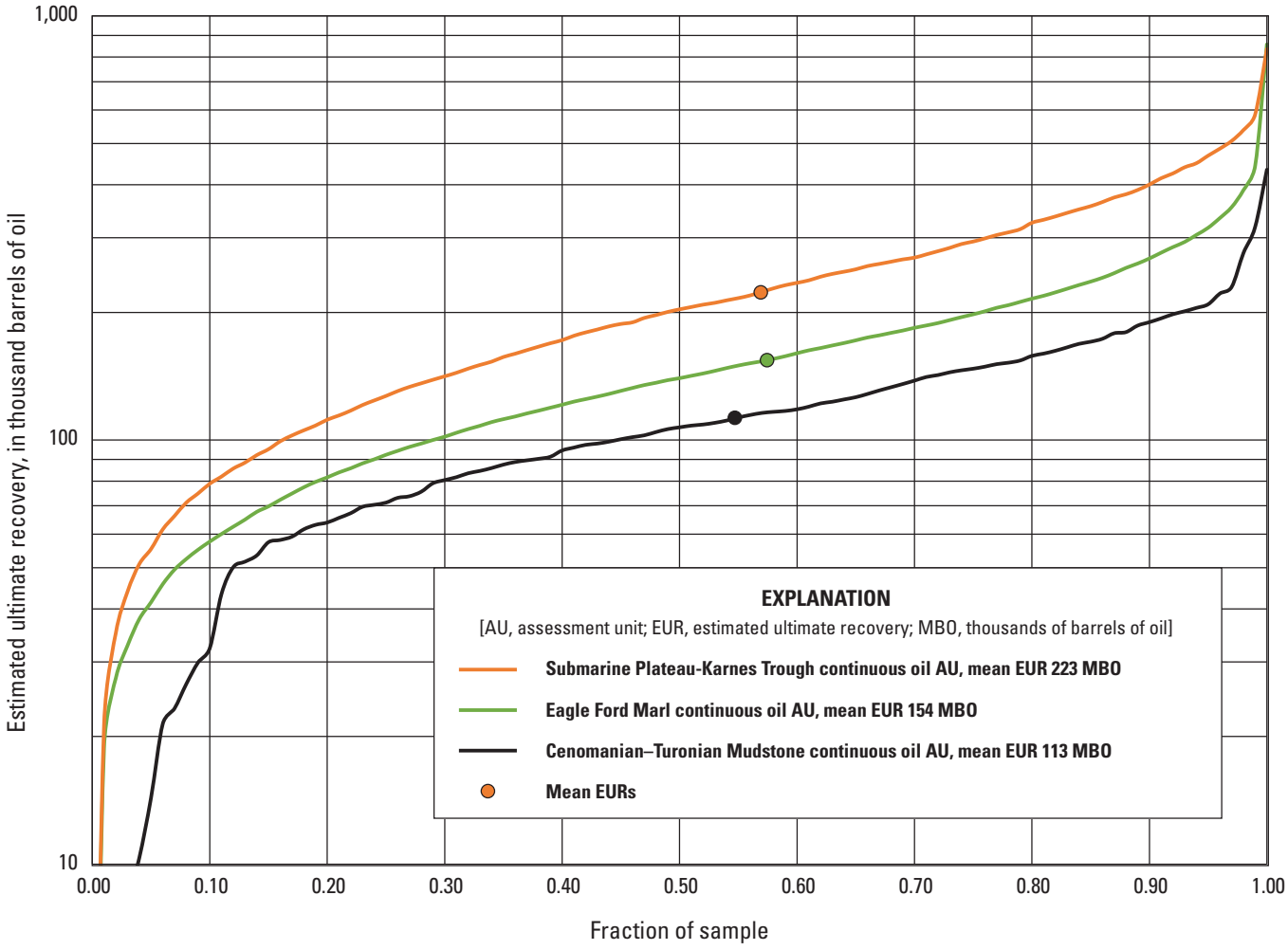


Figure 2. Estimated ultimate recovery (EUR) ranges for wells in the three oil Assessment Units (AUs) of the Eagle Ford Group and associated Cenomanian–Turonian strata of the U.S. Gulf Coast in Texas.

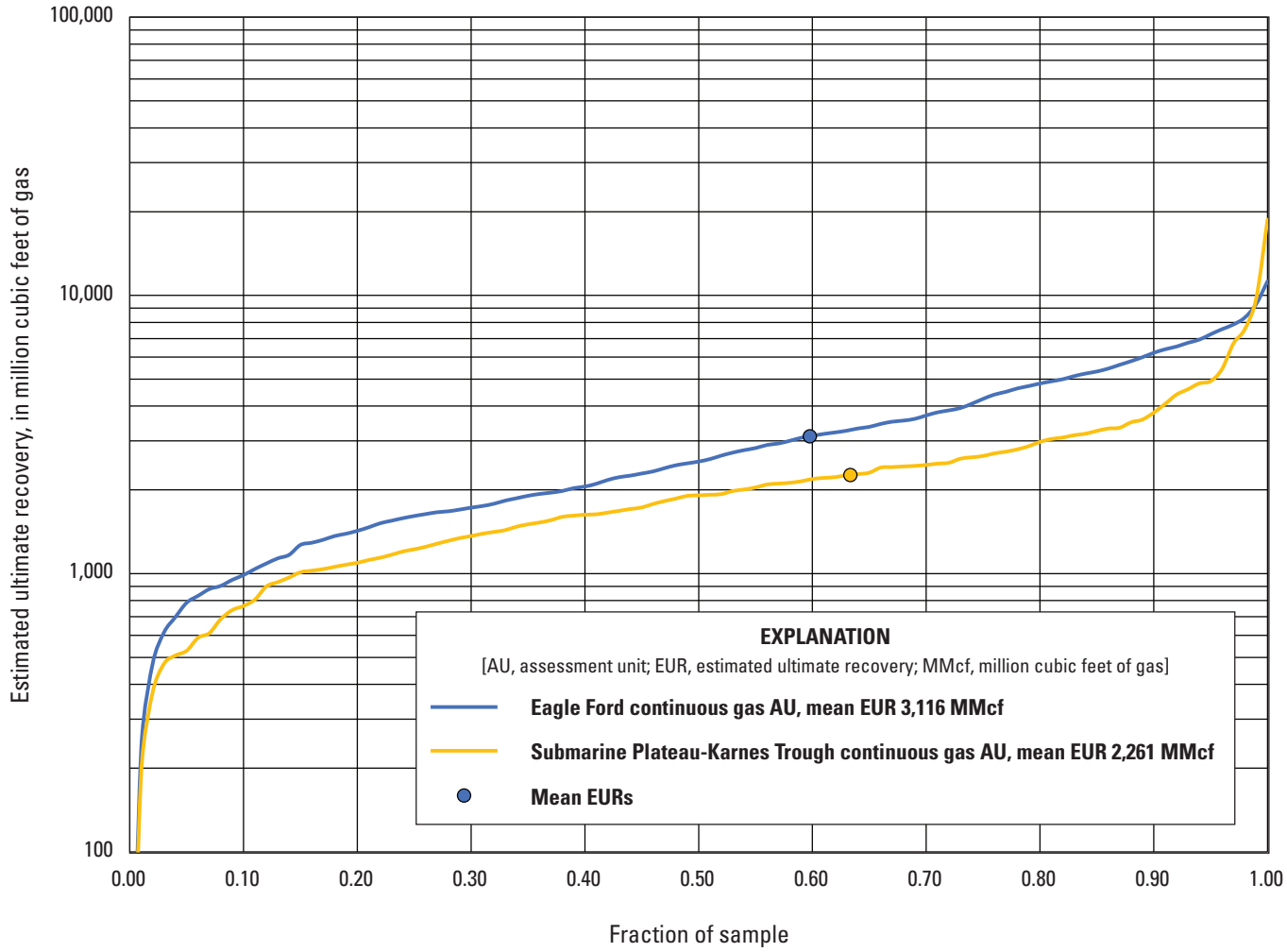


Figure 3. Estimated ultimate recovery (EUR) ranges for wells in two of the four gas Assessment Units (AUs) of the Eagle Ford Group and associated Cenomanian–Turonian strata of the U.S. Gulf Coast in Texas.

Results

The largest mean oil EUR was in the Submarine Plateau-Karnes Trough Continuous Oil AU at 223 MBO. The smallest was in the Cenomanian–Turonian Mudstone Continuous Oil AU at 113 MBO. The Eagle Ford Marl Continuous Oil AU mean EUR was 154 MBO. The largest mean gas EUR was in the Eagle Ford Marl Continuous Gas AU at 3,116 MMcf. The smallest was in the Submarine Plateau-Karnes Trough Continuous Gas AU at 2,261 MMcf. A mean EUR could not be calculated for the Cenomanian–Turonian Mudstone Continuous Gas AU, and the Cenomanian–Turonian Downdip Continuous Gas AU was not quantitatively assessed. The mean EURs and range EURs are helpful in calculating overall well productivity and were used to build mean EUR probability distributions for the 2018 resource assessment fact sheet.

Summary

This report outlines the steps taken to calculate estimated ultimate recoveries for continuous assessment units in the Eagle Ford Group and associated Cenomanian–Turonian strata in the U.S. Gulf Coast of Texas. The final calculated values, ranges, and means of estimated ultimate recoveries in the assessment units were used as guides for a geologically based resource assessment.

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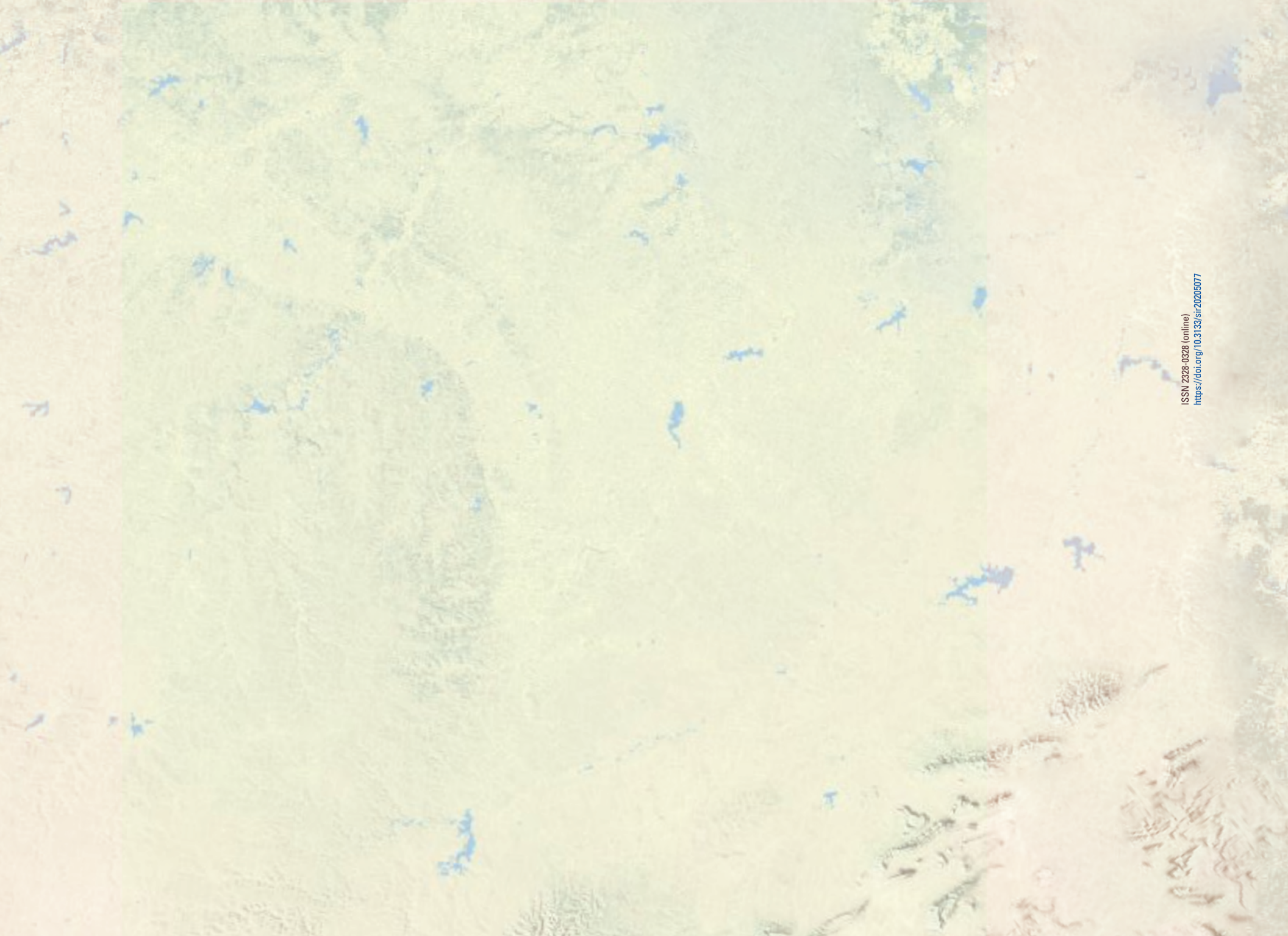
https://www.usgs.gov/energy-and-minerals/energy-resources-program/



ISSN 2328-0328 (online)
https://doi.org/10.3133/sir20205077