

Geology and Petroleum Potential of the Susitna Basin, South-Central Alaska

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ABSTRACT

The U.S. Geological Survey and Alaska Department of Natural Resources are cooperating in scientific investigations to provide increased understanding of the geology and petroleum potential of the Susitna basin, south-central Alaska. This joint effort has generated new information through interpretation of 425 line-miles of seismic data, gravity and magnetic modeling, stratigraphic and structural studies, and organic geochemical analyses. The Susitna basin is adjacent to the oil-and-gas producing Cook Inlet basin and separated from it by the Castle Mountain fault, a strike-slip fault with more than 100 km of post-Jurassic right-lateral displacement. The Susitna basin consists of Paleogene and Neogene nonmarine coal-bearing strata about 4-5 km thick that are broadly similar in lithology and age to the Cook Inlet basin but have been penetrated by only seven exploratory wells that found indications of gas associated with coaly horizons but no commercial petroleum production. Mesozoic marine shales that are the source rocks of oil in the Cook Inlet basin have not been found in the Susitna basin or in the surrounding uplands. The deepest strata in the Susitna basin comprise a 2-km-thick sequence of late Paleocene to middle Eocene nonmarine coal-bearing sedimentary and volcanic rocks that are hypothesized to record crustal extension, volcanism, and sedimentation related to subduction of an oceanic spreading ridge. This Paleogene sequence is unconformably overlain by Miocene and younger nonmarine coal-bearing strata greater than 2.5 km thick in a depocenter that is bounded by steep, north-striking reverse faults and likely formed during contractional tectonism associated with subduction of the Yakutat microplate beneath south-central Alaska. The Peters Hills basin, located northwest of the main Susitna basin depocenter, consists of a 2-km-thick sequence of Miocene and younger coal-bearing nonmarine strata that may have been deposited in a thrust-top or 'piggyback' basin above a hypothesized Broad Pass thrust fault. Basement rocks beneath Paleogene strata in the Susitna basin have not been reached by wells but are inferred from surface geologic mapping and aeromagnetic information to include pre-Cenozoic metamorphic and plutonic rocks similar to those in the nearby Talkeetna Mountains as well as strongly deformed Jurassic and Cretaceous flysch. The Susitna basin appears to be prospective mainly for microbial methane. Coal and carbonaceous shale of Paleocene to Miocene age are likely source rocks of microbial methane and are shown by Rock-Eval pyrolysis and other laboratory analyses to be possible sources of oil and thermogenic gas. Potential reservoir rocks include Eocene and younger fluvial sandstones, many with more than 30 percent porosity and more than 1 Darcy permeability. Potential seals include fine-grained fluvial overbank deposits. Several undrilled structures have been identified on seismic profiles. Vitrinite reflectance values of strata in the Trail Ridge Unit 1 well, the deepest well in the basin with a true vertical total depth of 3.85 km, suggest that the projected depth to the top of the oil window (Ro of 0.6 percent) is about 5.1 km. A hypothetical and very speculative oil play may be present along the southwestern margin of the basin where coal-bearing strata may

have been structurally buried and reached thermal maturity at depths of 5.1 km or deeper beneath the northeast-directed Beluga Mountain thrust fault.