

The Origin of Natural Fractures in the Antrim Shale, Michigan

Murray M. Matson

West Bay Exploration Co., Senior Geologist, Traverse City, Mi 49684 murray@wbeco.net

The Antrim Shale of the Michigan Basin is a black organic shale that was deposited in the Late Devonian. The Antrim is the primary unconventional gas target in Michigan and is ranked number thirteen in term of gas volume in the United States. The shale produces from a depth ranging from 300 to 1800 feet in an area of northern Michigan where the Antrim is naturally fractured. The natural gas produced is believed to be biogenic in origin, formed by the influx of fresh water bacteria into the organically rich shale. Fresh waters most likely enter the Antrim outcrop, located immediately north of production, during time of glaciation. Numerous studies have concentrated on the source and generation of natural gas in the Antrim but no theory has adequately explained the localized presents of natural fractures.

The Antrim Shale is present though out most of the Michigan Basin. Extensive drilling in all areas of the Basin has proven that only a several county area of northern Michigan was naturally fractured enough to sustain gas production. Currently the most accepted theories for this localized fracturing are (1) Paleozoic Tectonics related to the Mid-Continent Rift or Grenville Front (2) post glaciation rebound (3) hydraulic pumping and (4) frost wedging. The first two of the theories (1 & 2) fail to explain the fractures localization since most of the Michigan Basin has been tectonically active and covered by thick glacial ice. The other two theories (3&4) do not define a mechanism for propagating the fractures over 30 miles south from the Antrim subcrop.

Depositional models and cross sections indicate that localized Antrim fracturing in northern Michigan is the result of extensive leaching of the Detroit River Salt below the Antrim. Fresh waters, introduced during Pleistocene glaciation have dissolved the upper Detroit River salts over a four county area resulting in collapse of the overlying beds. The more brittle shales such as the Norwood and Lachine Members of the Antrim were more intensely fractured during the collapse. Natural fractures have been enhanced by structural flexures but the primary fractures result from collapse. County wide A1 Salt dissolution in SW Michigan is an example of this process.