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KANSAS AMBER: HISTORIC REVIEW AND NEW DESCRIPTION

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Abstract

Kansas is one of several sites worldwide in which Cretaceous age amber has been found. The purpose of this article is to provide a historic review and description, as well as to present new information in the form of infrared absorption spectroscopy data for this occurrence of amber from Kansas. Jelinite has similarities to other fossil resins in the cedarite group and the spectra of modern resin synthesized from the Araucariaceae.

A Brief Introduction to Cretaceous Amber in North America

Fossil resin and copal occur on the North American continent among strata from Triassic to Recent. The oldest amber on the North American continent is found in the Upper Triassic Chinle Formation, New Mexico, USA (Grimaldi, Nascimbene, Luzzi, Case, 1998, p. 81). The next oldest deposits of amber are Cretaceous in age. The most abundant North American Cretaceous fossil resins are from the states of Alaska and New Jersey, USA and from the provinces of Alberta and Manitoba, Canada.

Harrington (1891) reported one of the earliest Canadian Cretaceous amber finds and called this fossil resin chemawinite after the name of the nearby Chemawin Trading Post located in Manitoba. This Hudson Bay Company outpost was given the Chemawin name by the indigenous peoples of the area (McAlpine and Martin, 1969, p. 819). Klebs (1897) described and named this same Canadian fossil resin cedarite after Cedar Lake, a lake fed by the Saskatchewan River. Amber resembling cedarite occurs at Medicine Hat, Alberta, associated with the coal deposits in the Cretaceous Foremost Formation, and near Bassano, Alberta, referred to as Grassy Lake. Grassy Lake amber has yielded many fossils, including the oldest known mosquito (Grimaldi, 1996, p. 25).

Alaskan amber was first mentioned by Dall (1870), while amber found on the Atlantic Coastal Plain, eastern United States, was first reported in 1821 (Grimaldi, 1996, p. 27). The eighteen fossil resin sites along the Atlantic Coastal Plain, primarily New Jersey and Staten Island, New York, have been detailed by Grimaldi, Beck, and Boon (1989). The United States has other less abundant, little known Cretaceous deposits, two such deposits are in Wyoming and Kansas. An Upper Cretaceous (Upper Maestrichtian) fossil resin found in Wyoming was recently described by Kosmowska-Ceranowicz, Giertych, and Miller (2001). This fossil resin, reddish-yellow in color and very brittle, was found embedded in clay of the Lance Formation, a compact, lime-free grey loam. A Lower Cretaceous (Late Albian) amber, also termed jelinite, was found in Kansas. This amber was associated with the shale and lignite of the Kiowa Formation and is the subject of this review and investigation.

A Historic Review of Kansas Amber

Although the most abundant North American amber sites were found in the nineteenth century, fossil resin in Kansas was first reported in the 1930s. John D. Buddhue described Kansas amber in a 1938 journal, *The Mineralogist*. After obtaining samples from a mineral dealer, Buddhue (1938a) published a generalized location of the find, physical property observations, and information on the resin's reaction to various chemical analyses (p. 7-8). Although amber is not a mineral, Buddhue assigned the name *kansasite* to the fossil resin. Several months later in the same journal, Buddhue (1938b) expanded on the geographic and geologic location, presented additional resin testing results, and proposed a new name for the Kansas resin, *jelinite*, in honor of the collector George Jelinek (p. 9-10). Jelinek found pieces of wood containing resin nodules and provided Buddhue, not only with Kansas amber specimens, but also sulphide impregnated wood samples from the associated lignite layers. Dr. G. F. Beck identified the likely resin-producing tree as *Araucaria* in origin, which he stated was consistent with the tree type that reportedly flourished during the Mesozoic in the area known today as Kansas and elsewhere in the Northern Hemisphere (Buddhue, 1938b, p. 9).

Schoewe (1942) described physical properties of Kansas amber in the *Kansas State Academy of Science Transactions*, and he provided a legal description, specific to the section, for the collection site (p. 262). Tolsted & Swineford (1948) published the first picture of this amber, in black and white, and provided a short description in *Kansas Rocks and Minerals* (p. 29, 35-6). The picture and description were included again in two later editions (Tolsted & Swineford, 1957 & 1971, p. 31, 39). R. Langenheim, Buddhue, & Jelinek (1965) proposed a detailed stratigraphic provenience for jelinite based on Jelinek's first-hand information and Langenheim's study of available geologic literature; although devoid of obvious fossil flora and fauna, their report appeared in the *Journal of Paleontology* (p. 283-287). J. Langenheim (1969) summarized geographic distribution of ambers worldwide, according to geologic age and botanical affinities, and included Kansas amber (p. 1160). She stated that Araucariaceous pollen and cones had been described from Cretaceous amber deposits and that infrared spectra corroborated the araucarian origin for some amber localities; Langenheim also noted that Araucarians disappeared in the Early Tertiary in the Northern Hemisphere (p.1161-1162). Rice (1980) mentioned Kansas amber and reported that less than 50 pounds had been found (p. 211).

Even though Kansas amber was actively collected for less than 15 years, Jelinek provided several museums with specimens, including the Museum of Paleontology, University of California at Berkeley (Langenheim, et.al., 1965, p. 287). Wagonner (1996) used these samples to analyze jelinite's microfossil content and was the first to publish the microfossil assemblage, which is available in the online journal *PaleoBios*. Kansas amber images and descriptions have appeared in two additional online publications, *GeoKansas* by Brosius (2000-2001) and the *World of Amber* by Aber (1996-2001). Although museums and university collections have raw amber specimens, no amber artifacts from archeological sites have been reported to date in the region (D. Peterson, pers. comm., February 22, 2001).

Geographic Location of Jelinite

Buddhue (1938a) provided a generalized geographic location of the amber find, over 30 km (20 miles) from the city of Ellsworth in Kansas (p. 7). A direction from the city and a county name were specified in a later article (Buddhue, 1938b, p. 9). Ellsworth is located in Ellsworth County, north central Kansas, in the Smoky Hills physiographic province (Fig. 1).

Generalized Physiographic Map of Kansas

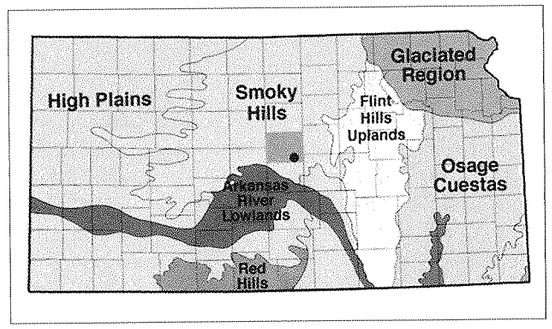

Fig. 1. Jelinite was collected from Ellsworth Country (EW), Kansas

Schoewe (1942) published a legal description, specific to the section, and stated the fossil resin collection site was 8 km (5 miles) south of Carneiro (p. 262). The most precise location, NW1/4, SW1/4, sec. 18, T. 16

S., R. 6 W., was published after the site was submerged in the early 1950s with the construction and filling of Kanopolis Reservoir (Langenheim, et.al., 1965, p. 284). Rare finds have been reported since the destruction of the original collection site (P. Johnston, pers. comm., January 7, 2001). Only one amber collecting area outside of Ellsworth County, has been mentioned in print, an addendum to the Schoewe article that stated amber fragments had been found in southeastern Logan County (Schoewe, 1942, p. 262).

Geologic Location and Depositional Environment

Cretaceous bedrock outcrops in Ellsworth County. According to O'Connor (1968), the Lower Cretaceous Series in Kansas is composed in ascending order of Cheyenne Sandstone, Kiowa Formation, and Dakota Formation (p. 54-56). These rocks represent a transgressive-regressive cycle of sedimentation (O'Connor, 1968, p. 54). The nonmarine Cheyenne Sandstone (early late Albian) was deposited in fluvial and estuarine environments; the marine Kiowa Formation (late Albian), recorded a transgressive phase and marked the easternmost record of continental and paralic sediments (Franks, 1979, p. 6). While some of the Kiowa rocks were deposited in brackish, open-sea environments, lenticular deposits of sandstone were the result of barrier bars and shoreface accumulations (Franks, 1979, p. 7). The nonmarine Dakota Formation (spanning the Albian-Cenomanian boundary) marked the climax of a regressive phase and contains rocks and carbonaceous materials that are possibly remnants of delta-plain sediments deposited in a complex of shoal-water deltas (Franks, 1979, p. 7, 8).

Jelinite was reportedly found at a cliff exposure along the meandering Smoky Hill River, in shale overlain by 10 cm (4 inches) of "semi-coal and charred wood", more than 18 m (60 feet) below the land surface and 1 m (3 feet) above water level (Buddhue, 1938a, p. 7). After obtaining more information, Buddhue (1938b) reported the jelinite occurred between layers of coal separated by gravel, gypsum crystals, pyrite, and lignite (p. 9). Langenheim, et al. (1965) concluded that nodules of resin were embedded in a "layer of soft sulfur-colored clay bounded by two thin lignite layers" which were about 10-30 cm (4-12 inches) apart and were exposed over 61 m (200 feet) in length (p. 284). Langenheim, et al. surmised jelinite's source to be either Kiowa Shale or from one of two members of the Dakota Formation, the Terra Cotta Clay Member and Janssen Clay Member. The available literature mentioned lignite, fossil leaves, and lignitized wood fragments in the two Dakota layers, but at that time lignitized logs and sticks had been mentioned occurring only in sandstone bodies within the Kiowa Shale (Langenheim, et. al., 1965, p. 286).

Janssen and Terra Cotta type localities were near to the amber collection site and Langenheim, et al. (1965) initially speculated the resin deposit's source was most likely the Terra Cotta Clay Member (p. 286). However, based on a detailed stratigraphic description of the north bluff of the Smoky Hill River, 2 miles west of the jelinite collection site, Langenheim concluded the fossil resin was most likely obtained from the Kiowa Shale because it would have outcropped near river level, while the Terra Cotta Clay would have been above the river by some 17 m (50 feet) (p. 286). This assessment is consistent with recent reports of a sandstone and associated carbonaceous material outcropping at the shoreline of the present lake that is identified as upper Kiowa or lower Dakota (Buchanan, McCauley, and Sawin, 1996, p. 1). Whether this present shoreline deposit is interpreted to be marine barrier bars deposited near the margin of the Kiowa sea (Franks, 1980) or lower Dakota fluvial, nonmarine streams with incised valleys (Hamilton, 1989), it is presumably over 17 m (50 feet) above the amber-bearing strata. Franks (1980) generalized interpretation that the "transgression of the Early Cretaceous Kiowa sea in north-central Kansas led to deposition and preservation of fluvial, estuarine, and lagoon or bay deposits behind the Kiowa barrier systems" is consistent with many amber-bearing strata depositional environments (p. 56). Amber's specific gravity is slightly over 1 and it floats in saltwater and therefore occurs in estuarine or marine deposits, transported some distance from the original site (Langenheim, 1969, p. 1159).

Jelinite Properties

Jelinite has attracted little attention because the rarity, lack of obvious macrofossils, and poor durability combine to make it unsuitable for jewelry purposes and unavailable to most collectors or researchers. It is a semi-translucent to opaque, yellow to brown amber (Fig. 2). The opaque variety is light to dark yellow with a waxy luster and marbled appearance. Schoewe (1942) described this type as a light butterscotch to brown color with a banded, agate-like appearance (p. 262). Waggoner

Fig. 2 Jelinite types. Coin is 2.5 cm in diameter.

(1996) described jelinite as "yellow to dark brown, sometimes thinly banded, opaque and often 'fatty' in color and texture" (p. 20). The semi-translucent type is dark orange to brown in color with a resinous luster. Unbroken specimens are covered with a thin gray brown crust. Schoewe (1942) reported the amber was in irregular lumps from very small up to pieces that measured 10 x 10 x 5 cm (4 x 4 x 2 inches) (p. 262).

Jelinite has a conchoidal fracture and hardness of 3. It is extremely brittle, which is consistent with a generalized observation Grimaldi (1996) made regarding all Cretaceous age amber (p. 24). The specific gravity of jelinite is approximately 1.05. It has a blue-white fluorescence, although Buddhue (1938a) reported a brilliant bluish green fluorescence (p. 7). When heated, it emits a resinous odor and smoky flame. According to Buddhue (1938a), ether softened the surface and dissolved a small amount; the resin was unaffected by nitric acid, glacial acetic acid, dilute potassium hydroxide, 28% ammonium hydroxide, and acetone; and the melted resin created a brown oil that gave a "weak succinyl-fluoescin test for succinic acid" (p. 8). Jelinite was reported to be about 38 percent soluble in cold chloroform (Buddhue, 1938b, p. 10).

Waggoner (1996) analyzed the microfossil assemblage of jelinite. Cysts of an amoeboflagellate, similar to the modern genus *Naegleria,* were reported and believed to be the first of such cysts known as fossils (Waggoner, 1993, p. 97). Additional investigations of jelinite yielded assorted spores and conifer pollen, sheathed filamentous bacteria, probable testate amoebae, and unicellular organisms of uncertain affinity (Waggoner, 1996, p. 20). Waggoner (1996) stated the sheathed bacteria (fossils, not contaminants, because they were completely encased in amber) were morphologically similar to the living genus *Leptothrix*, and testate amoebae, resembled the modern *Pontigulasia* and *Nebela* (p. 21- 22). Testate amoebae similar to the extant species *Nebela* was believed to be the oldest known record of this genus (Waggoner, 1996, p. 22). Although Waggoner (1996) believed conclusions based on so few specimens should be considered tentative, he speculated that jelinite's microfossil assemblage compared to "aquatic, oligo-mesosaprobic paleomicrohabitat" found in fossil resin from Bavaria (p. 20).

Infrared Absorption Spectroscopy

The geologic or stratigraphic occurrence, associated paleontological data, and detailed chemical analysis are used to describe and classify amber. Infrared absorption spectroscopy (IRS) is one fundamental chemical analytic technique used since the 1960s to identify and correlate worldwide fossil and modern resins. Regardless of the age and location of amber, the graph produced using IRS is a kind of fingerprint of the resin with peaks or absorption bands reflecting major chemical constituents that can be compared (although not always) to show structural similarities of these constituents between fossil and modern resins. Therefore, IRS studies are useful in establishing botanical affinity (Langenheim, 1966, 1969) or for provenience analysis of archaeological amber artifacts (Beck, Wilbur, and Meret, 1964; Beck and Shennan, 1991), as well as in cataloging and classifying resin types (Langenheim and Beck, 1968; Kosmowska-Ceranowicz, 1999).

Infrared absorption spectroscopy was performed on jelinite and the resulting IR curve is shown along with other similar Cretaceous resin spectra (Fig. 3). The jelinite IR curve (IRS 537, 538) is comparable to the fossil resin infrared absorption spectra for Wyoming, USA (IRS 508) (Kosmowska-Ceranowicz, Giertych, and

Miller, 2001), and the Canadian specimens from Manitoba, Cedar Lake (IRS 369) and Alberta, Grassy Lake (IRS 474) (Zobel, 1999). On the basis of IRS investigations and the similarity to these Cretaceous ambers, jelinite could be included in the cedarite group of fossil resin.

Jelinite's IR curves were similar to spectra for Lower Cretaceous retinite from Azerbaijan (IRS 397), Late Tertiary ambrite from the Auckland province, New Zealand (IRS 292), Cretaceous ajkaite from Ajka, Romania (IRS 303), Cretaceous walchowite from

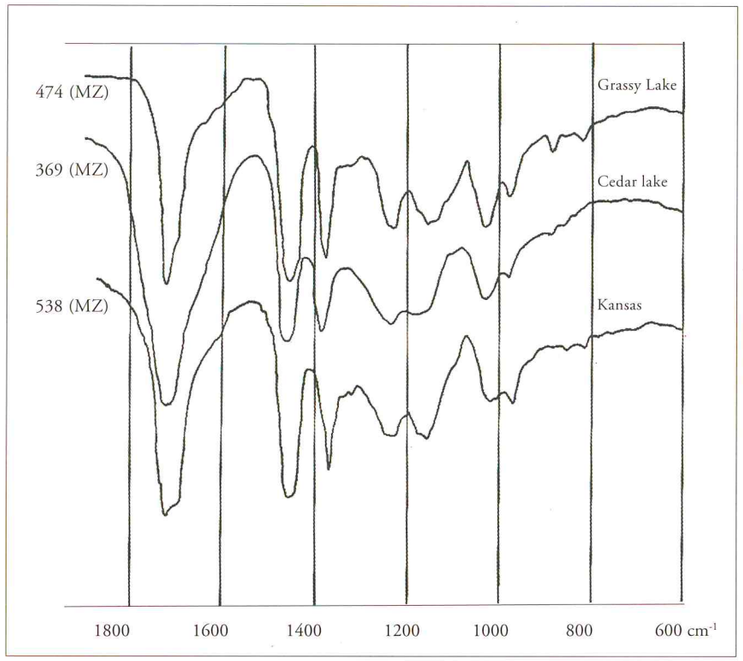

Fig.3 Infrared spectra of jelinite and similar Cretaceous fossil resins.
(1) IRS 369 – cedarite, Cedar Lake, Cretaceous (MZ inv. no. 2148, from coll. of Univerity in Toronto);
(2) IRS 474 – cedarite, Grassy Lake, coal mine near the village of Bassano, Southern Alberta, Cretaceous (MZ, coll. A. Zobel)*
(3) IRS 357– jelinite, Ellsworth County, Kansas, Lower Cretaceous
(MZ, from coll. Emporia State Univerity)

Moravia, Czech Republic (IRS 324), trinkerite from Gams, Austria (IRS 295), resins from France, such as the resin from Auvergne (IRS 299), and a fossil resin as reported by Mr. Bauer as schliersite from Schliersee, Bavaria (IRS 256, 257) (Kosmowska-Ceranowicz, 1999, p. 109, 112, 113). All of these spectra can be compared to that of the resin of living *Agathis australis* (IRS 50). These similarities in IR data, are consistent with Buddhue (1938b) and Langenheim and Beck (1968) who suggested jelinite and other fossil resins originated from the *Araucariaceae* in spite of the fact that these gymnosperms no longer occur in the Northern Hemisphere.

Conclusions

Although many amber finds in North America were reported in the nineteenth century, the fossil resin in Kansas was not reported until 1938. Kansas amber, also known as jelinite, was gathered from clay and lignite seams at the base of a cliff exposure of shales and sandstones along the meandering Smoky Hill River. This fossil resin-rich layer was surmised to be the Lower Cretaceous Kiowa Formation, and was located in Ellsworth County, Kansas. Amber was actively collected for less than 15 years because this cliff exposure was submerged when the area was flooded for a reservoir.

Although several museums house small collections of Kansas amber, fossil resin artifacts have not been reported in archeological sites in the region.

Kansas amber is translucent to opaque, dark orangish-brown to yellow, with a resinous to waxy luster. It is extremely brittle, has a conchoidal fracture, and specimens are covered with a thin gray crust. The likely depositional environment for the amber bearing strata is near shore, coastal lagoons and estuaries behind barrier islands. Jelinite's infrared spectrum is similar to Cretaceous resins from Wyoming, USA, and the Canadian Cedar Lake, Manitoba, and Grassy Lake, Alberta and could be included in the cedarite group of fossil resin. These IRS data correlate to other fossil resins found in sediments in Asia and Europe, and to resin of the living *Agathis australis* (Kauri pine). This data suggests Kansas amber originated from the *Araucariaceae* in spite of the fact that these conifers are restricted to the Southern Hemisphere today.

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