the desired equilibrium state are more easily controlled in the closed system and (ii) because faster vapor diffusion and uncovered dishes allow the equilibrium state to be reached more rapidly than in the air oven (*5, 6*).

The medium- and fine-clay fractions are given a NaOH treatment (*8*) for the removal of amorphous and poorly crystalline materials (*1*). The sample is then boiled in a NaOAc buffer at *p*H 5 and magnesium-saturated by $MgCl_2$ and $Mg(OAc)_2$ washings (*9*, pp. 183–4). Magnesium saturation was adopted because hydrogen saturation (*1, 6, 9*) liberates aluminum from the clay and apparently causes polymerization of the glycerol molecules in the montmorillonite interlayer positions when the clay is subjected to a high temperature in an evacuated atmosphere. Also, magnesium-saturated samples are commonly used for identification of layer silicates by x-ray diffraction (*9*).

The aluminum dishes, of heavy duty foil shaped over a square bottle (1.25 inches on a side), are passivated by half filling with distilled water and evaporating it prior to addition of the sample. An empty aluminum dish (weighing blank) and a standard montmorillonite sample are run with each group of 8 to 14 clay samples, all of which are placed in a large aluminum tray. Periodically, a dish of glycerol is placed in the oven to maintain the droplets on the glass in the door (Fig. 1); however, the dish is not left in the oven longer than necessary (usually 3 or 4 hours). A dish of $CaSO_4$ desiccant is kept on the oven floor to provide an absorbant for any water vapor in the oven. Samples reach equilibrium in 24 to 48 hours and are weighed at 8- to 12-hour intervals after 24 hours until constant weight is reached. Weighings are made promptly after the dishes are removed from the oven, and, where possible, in an atmosphere of less than 40-percent relative humidity. Calculations, including those for external edge surface, are made according to the published procedure (*1; 9*, pp. 331–341).

Under the conditions of the proposed method, montmorillonite sorbed a mono-interlayer of glycerol having liquid glycerol density, thus providing quantitative specific surface analysis (Table 1). The 2- to 0.2-μ fraction contained 5 percent illite based on the K_2O content (*6*) and a trace of quartz as determined by x-ray diffraction analysis. Vermiculite apparently adsorbed a mono-interlayer of somewhat less than liquid glycerol density. The only impurity detected in the vermiculite was illite (16 percent); therefore, the surface results appear low (*10*).

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Devonian Plants from the Type Section of the Ghost River Formation of Western Alberta

Abstract. Plant fossils, including branched axes, foliar structures, fructifications, and dispersed spores have recently been discovered from the type section of the Ghost River formation. The megafossils, although commonly fragmentary, suggest a late Middle or early Upper Devonian age for the beds. This discovery suggests that equivalent strata in other regions may also contain plant remains, the discovery of which would add significantly to our knowledge of Devonian floras in western North America.

Compressions of vascular plants, including isolated sporangia, sporangiferous branches similar to *Svalbardia* (Protopteridiales), laminae superficially resembling *Platyphyllum* (affinities unknown), and branched and unbranched axes containing scalariform tracheids, have recently been discovered in the type section of the Ghost River formation. Triradiate spores with an observed size range of 30 to 98 μ have also been found in specimens of shaly dolomite, and include species of *Leiotriletes, Punctatisporites, Ambitisporites*, and *Retusotriletes*. This discovery is the first record of plants from the Ghost River formation, and is also the only record of Devonian plant megafossils from western Canada south of the Yukon Territory.

The type section of the Ghost River formation is located in the Front Range of the Rocky Mountains, on the west side of the north branch of the Ghost River, a few miles north of Lake Minnewanka. The locality was designated by Walcott (*1*) as follows: "The type locality is about 51 miles west 20°N of Calgary, Alberta, Canada, in the first small canyon south of Ghost River canyon and opening on the Ghost River as the river bends south."

Walcott (*1, 2*) originally assigned 285 feet of red and green shales, and buff-weathering dolomites, to the Ghost River formation, believing that these rocks constituted a completely new formation representing an interval from Middle Cambrian to Devonian. However, this series is very similar to the underlying Arctomys formation of Cambrian age, and field geologists have long been confused as to the age of the Ghost River formation and its stratigraphic relationships to surrounding Cambrian and Devonian strata (*3*).

Field investigations of 1959 and 1960 revealed that the Ghost River formation, as defined by Walcott, is split by an unconformity rather than bounded above and below by unconformities. This intraformational unconformity has been recognized in two different sections that were measured in the cirque draining into Walcott's "first small canyon south of the Ghost River canyon." The fossil plants were found in beds 25 to 30 feet above the unconformity, and suggest a late Middle or early Upper Devonian age for the upper series of rocks.

As a result of the discovery of the sub-Devonian unconformity and Devonian fossil plants, it is herein proposed that the Ghost River formation at its type locality be restricted to a thickness of 145 feet, consisting of an interbedded and variable sequence of red and green dolomitic shales, together with buff weathering, pale brown, and green-grey dolomites. The Ghost River formation rests unconformably on the Cambrian Arctomys formation, and interbeds above with the basal few feet of the overlying Fairholme group of Upper Devonian age. The overall thickness and approximate contacts are shown in Fig. 1*a*.

The megafossils appear to have close relationships to species of a flora described by Høeg from the uppermost Middle Devonian (or possibly lowermost Upper Devonian) of Spitzbergen (*4*), and also to species described by Kräusel and Weyland from the upper Middle Devonian of Germany (*5*). A more definitive statement concerning the age of the plant-bearing strata is being reserved until additional investigations have been concluded.

The megafossils are generally delicate in appearance, and mostly fragmented. Some, however, are more nearly complete; one of these is illustrated in Fig. 1*b*. It consists of a repeatedly branched and stout axis, bearing bifurcating flabelliform leaves as well as a loose, spikelike strobilus. It is improbable that such an apparently delicate fragment could have withstood water transport for any great distance. The sedimentary environment appears to have been quiet, near-shore, shallow, and marine to brackish. Some of the plants that contributed to the fossil flora were evidently quite large, as stem compressions up to 5 inches in diameter have been collected.

A search of the immediate outcrop area failed to disclose other plant-bearing beds. However, the presence of spores at the type section suggests that spores may also occur at other localities in the Ghost River formation, and may be potentially useful as correlation indices. In addition, it is possible that equivalent strata in other regions of the Front Range will contain plant megafossils. Additional discoveries of such plants would markedly increase our knowledge of Devonian floras in western North America, and be of great assistance in statigraphic interpretations (*6*).

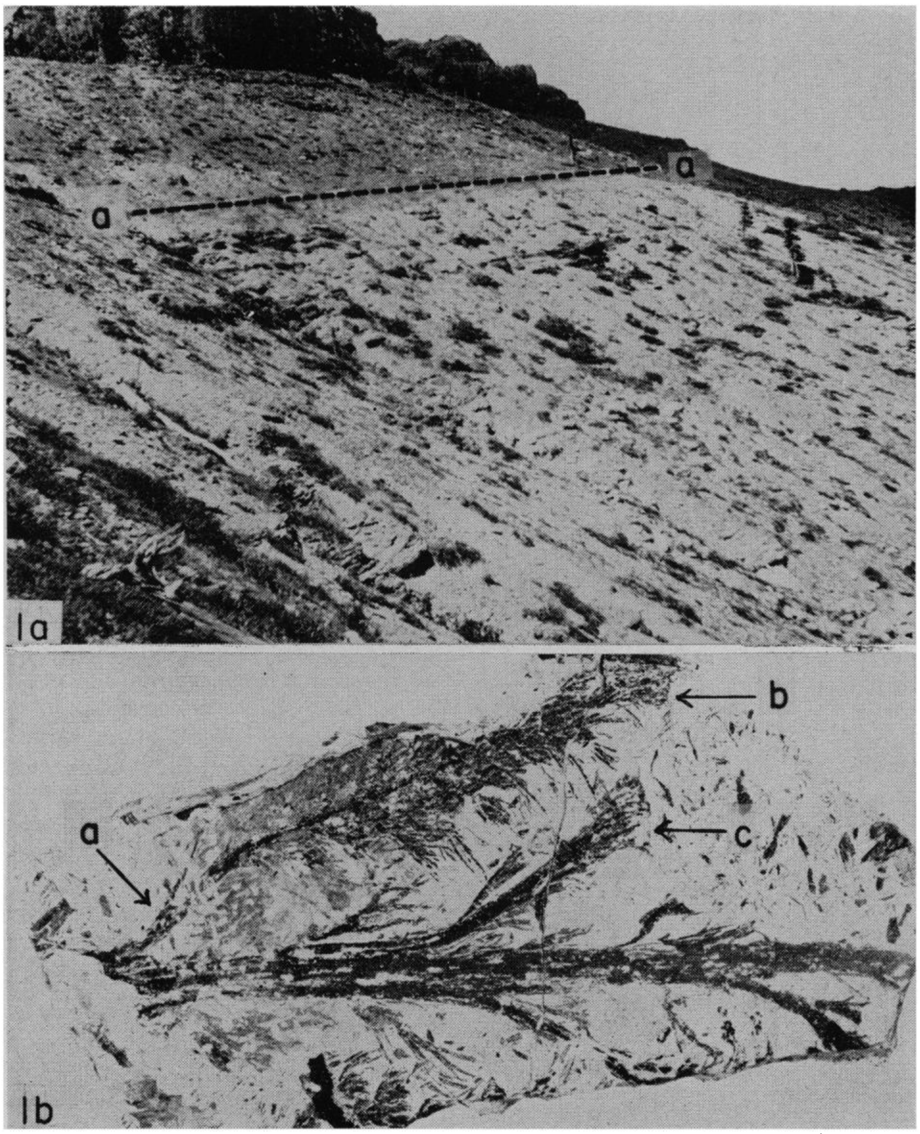

Fig. 1. (*a*) View of the Ghost River formation looking west. The approximate contact with the overlying Fairholme group is indicated by the broken line *aa*. The collecting site is near the bottom right-hand corner of the photograph, and the contact with the underlying Arctomys formation is some 30 feet below the collecting site. (*b*) One of the plant axes from the Ghost River formation. Note the attachment of the strobilus at *a*; the tip of the strobilus at *b*; and a dichotomously branched leaf-like appendage at *c* (× 1).

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