THE LEWIS OVERTHRUST

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The Lewis overthrust, famous structural geological feature, extends from Glacier National Park in Montana some 350 miles north into Alberta, Canada; is from 15 to 30 miles wide; and is believed to have been thrust eastward some 35 miles. This is often referred to in texts as a classic example of a large overthrust, but only one of many such observed throughout the world. Evidence for such overthrusting usually offered, is the inverted order of the fossil sequence in the strata, according to the assumed evolutionary advance of biological life during the geological ages, and so contained in the time-stratigraphic rock sequences from older to younger rocks.

In the case of the Lewis overthrust rock formations, the so-called "older" algal fossils are confined to the Precambrian Belt series of rocks, which lie above the so-called younger Cretaceous rocks, so correlated because of the index Cretaceous fossils they contain.

Such confidence have paleontologists and stratigraphers had in the correctness of their evolutionary hypothesis that in many cases little effort has been spent in examining the physical evidences accompanying such overthrusting.

Some field work has been performed during the summer of 1968 in attempting to overcome this deficit. So far such investigations have failed to turn up any pronounced evidence to uphold the hypothesis of a Lewis Overthrust. Photographs of contact lines indicate that the Precambrian strata were water deposited on top of the Cretaceous.

Introduction

One of the many facets of geology is the study of the structure of the earth, that is the framework on which it is built and which holds it together. Such study also deals with the forces that have acted and are acting in the earth that have produced its present structure.

Due to stresses that develop within the crust of the earth, the geomorphology (shape) of the earth's features changes from time to time. If stresses develop slowly topography may be altered through plastic flow; if stresses build up more rapidly, they may be relieved through fractures or faulting.

There are three principal types of faults: (1) Gravity, or normal faults, (2) Strike-slip faults, and (3) Thrust faults. Deep in the mantle of the earth where heat and pressure build up, deformation is more apt to take the form of plastic flow, or possibly metamorphism. Chemical reactions take place which break down some minerals and form new ones, during metamorphic movement.

Near the surface of the crust where rocks are cooler and pressures less, the usual manner of stress relief is through faulting and jointing. Both are fractures, but joints have no differential movement, while faults do.

Gravity faults or normal faults are tension fractures because they lengthen the surface. Strike-line faults may be near vertical with one side moving in relation to the other, like the San Andreas Fault in California. Thrust faults are low angle faults as a rule with the upper limb being pushed over the lower member, thus shortening the surface. The thrust faults in the Alps, one of the most studied thrust-fault areas in the world, are said to have shortened Europe by many miles–the Glarus overthrust being one of the most notable with net slippage of at least 20 miles.

Aside from the Alps, perhaps the most studied thrusts are in Scotland, the Ben More and the Moine. There are many other famous thrust-faults, one in the vicinity of Buffalo Mountain, Tennessee. In the Muddy Mountains of Nevada there are two major overthrusts, with a net slip of 15 miles. The Bannock overthrust in Idaho is about 270 miles in length with a stratigraphic throw of 15,000 feet (vertical displacement).

Since these field studies were completed and it was finally settled that these structural features were indeed thrusts, little field work has been performed to verify from a mechanical standpoint the authenticity of many thrusts. For example an employee in Glacier National Park, Montana, told me during a recent visit that as far as he knew no new geological work had been done in the park in the past twenty years.

But why all this special interest concerning thrusts? The basic answer is that a scientific controversy–long considered settled, buried, and forgotten–has of late been resurrected, and many scientists are once again examining the evidences for evolution. In earlier approaches to the subject conclusions were reached with greater emphasis on the paleontological and stratigraphical criteria than upon the structural and tectonic evidence, so convinced were researchers on the correctness of the macro-evolutionary hypothesis. This concept is well illustrated in a book by Nicholson:[1]

> It may be said that in any case where there should appear to be a clear and decisive discordance between the physical and the paleon-

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tological (fossil) evidence as to the age of a given series of beds, it is the former that is to be distrusted rather than the latter.

Thrust-faults or overthrusts, are very common and well authenticated. However their use, without adequate physical evidence, to "explain" the wrong order of fossils in the geologic column is highly questionable. Such has been the practice of geologists with regard to the Alps and elsewhere. Billings[2] takes note of this in his text *Structural Geology:*

> Parts of some of the great overthrusts in the Alps are so devoid of slickensides, gouge, breccia, and mylonite that they passed unnoticed and were for a time mapped as sedimentary contacts. It was only after paleontological evidence was obtained . . . that the existence of the great faults was recognized.

Re-examination of physical or structural evidence for the existence of some of these major thrust-faults is very pertinent. Three Arizona thrust faults were examined recently by Burdick and Slusher[3] and the following is a report on studies made at Glacier National Park in the summer of 1968.

Lewis Thrust Fault

This is one of the largest overthrusts in the United States; however, not all of it is contained in this country for it extends northward into Canada some 300 miles. The southern exposure is well seen along the eastern front of the Lewis range in Glacier Park. The cap rock in Glacier Park is classified as Precambrian, or the Belt Series, composed of several formations such as Kintla, Sheppard, Siyeh, Grinnell, Applekunny and Altyn.

The Altyn formation is the oldest of the Belt series, and lies at the bottom of the Belt, unconformably on the Cretaceus shale. It is a sandy dolomite with a light buff color; average thickness is 2,300 feet. On top of the Altyn lies some 3,000 feet of Applekunny green argillites. Mud cracks and ripple marks are common.

Because of their predominantly red color, the Grinnell argillites are the most conspicuous rocks in the park. This formation is also about 3,000 feet thick. Next above comes the Siyeh buff-colored limestone some 4,000 feet thick, the greatest cliff-former in the park. The Sheppard formation weathers yellow-brown, indicating ample iron, and is some hundreds of feet thick. The Kintla is another red formation and is seen only on top of the highest peaks. Purcell lava and a diorite sill form black bands around the park.

Characteristic fossils of the Belt series are various species of algae, very prominent along the highway west of Logan's pass. In fact the presence of these fossils is the main reason that

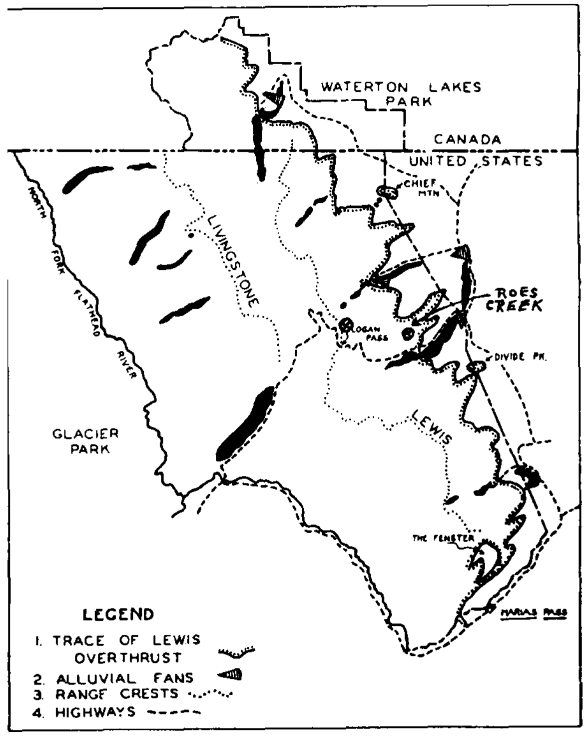

Figure 1. Map of Waterton-Glacier International Peace Park. From "The Geologic Story of Glacier National Park by James L. Dyson. Special Bulletin #3. Glacier Natural History Association in cooperation with National Park Service, U. S. Department of the Interior.

the Belt series of rocks are designated as Precambrian.

Predominant algae fossils of the Belt series are Collenia, Conophyton, and Cryptozoon. They bear a crude resemblance to the head of a cabbage. They are found in colonies especially in the Siyeh formation.

The Cretaceus shales and sandstones below the Belt series contain shells such as oysters and ammonites, index fossils for that period. We were able to dig out some of these fossils along Roes creek, near the Rising Sun campground on the west bank of St. Mary's Lake, a finger lake apparently gouged out by glaciers.

The dip of the presumed fault is very gentle, anywhere from nearly horizontal to 10 degrees. However, on Marias pass the dip steepens to almost 40 degrees. Actually the fault can be traced almost 100 miles south of the park. See maps in Figures 1 and 2.

To give a better background of the way orthodox geology explains the Lewis Overthrust, I quote excerpts from *The Geologic Story of Glacier National Park* by James L. Dyson, head of the Dept. of Geology of Lafayette College.[4] He was a ranger-naturalist at Glacier Park for eight years.

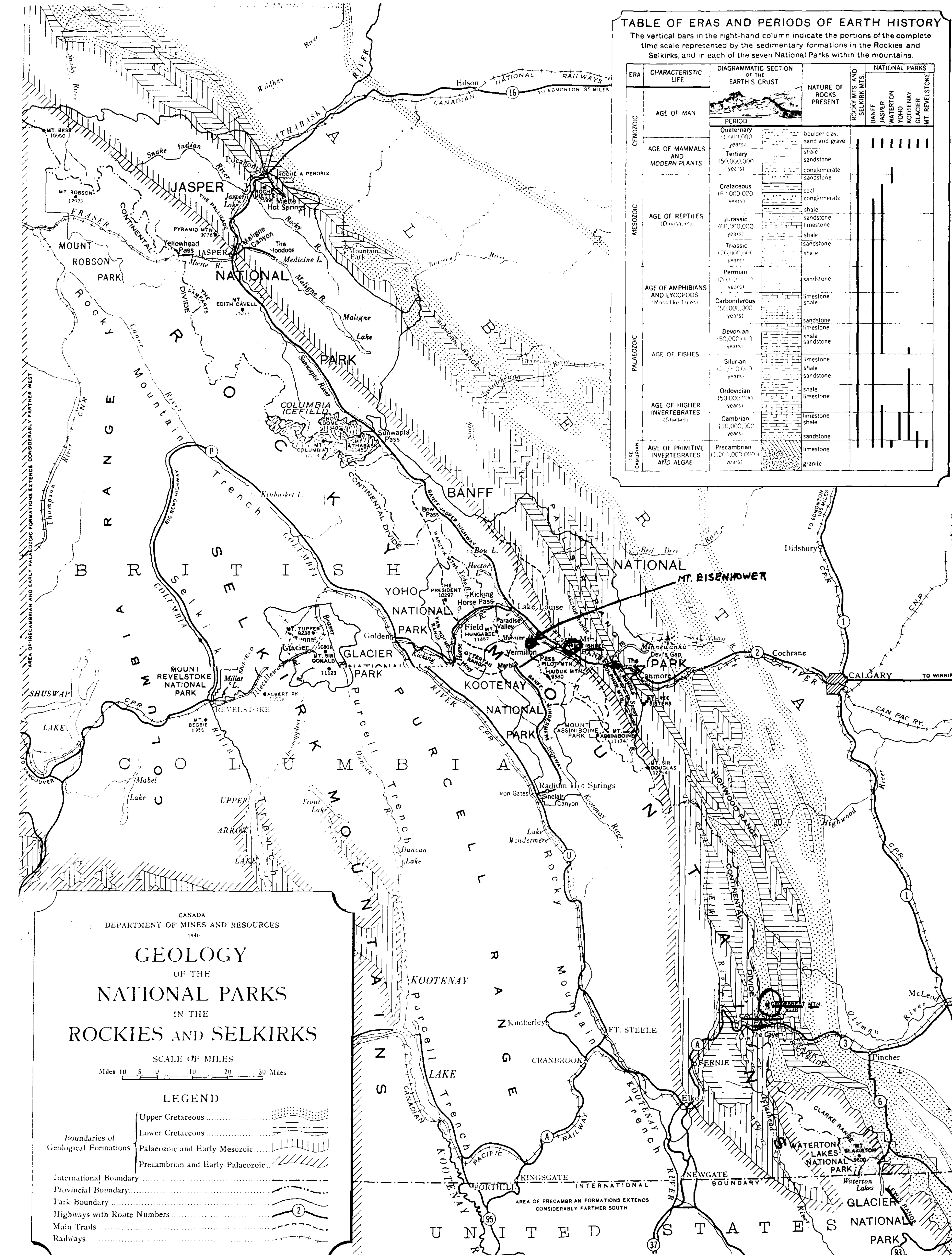

Figure 2. General area near boundary of United States and Canada. Region of Figure 1 located in lower right hand corner. From "Geology of the National Parks of Canada" by B. R. MacKay (Reprinted from *Canadian Geographical Journal).* National Parks Bureau, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Canada,

Figure 3. High on Summit Mountain, Glacier National Park, Montana. At Marias Pass. The light colored rock is Altyn dolomite, Belt Series, Precambrian, overlain by Grinnell and other Belt rocks. Note unconformity between Altyn and overlying Belt Series. The Altyn dips west; the overlying Belt (Grinnell) is at right angles, indicating metamorphic movement among Precambrian series. Below Altyn lies apparent conformable contact with Cretaceus shale. No evidence of differential movement.

Figure 4. Wynn Mountain unconformity contact between underlying tilted Altyn Belt Series Precambrian dolomite, and overlying metamorphosed Grinnell formation, both Precambrian. No signs of movement at the contact line.

Toward the end of Cretaceous time tremendous crustal forces, principally from the west, were directed against the geosyncline with the result that its rocks were compressed and uplifted, converting the site of the former sea into a mountainous region. . . . Similar activity resulted in the formation of the Rocky Mountain system stretching from Mexico to Alaska. . . . Mountain building forces continued for several million years in the Glacier Park area, finally squeezing the rocks into a great fold (anticline). Continued pressure from the west overturned the fold and put additional strain on rock layers, eventually causing them to break along a great low-angle fault. The Western limb of the fold, now a great slice of the crust, was driven upward and eastward over the eastern limb, ultimately reversing the order of rock layers by placing older on top of younger ones. . . . These younger layers are Cretaceous shales and sandstones underlying the plains immediately east of the mountains. The mountains themselves have been carved by streams and glaciers from the Belt formations comprising the upper block of older rock, that slice of the crust which has been moved more than 20 miles toward the east. . . . The Lewis Overthrust comes to the surface at the base of the Altyn formation along the entire precipitous east front of the Lewis Range and can be traced nearly 100 miles northward into Canada and almost an equal distance south of the park. Within the park it is tilted very gently toward the southwest, the angle of dip seldom exceeding 10 degrees. . . . And so we see that the mountains of Glacier National Park, unlike many of the world's great ranges, have no roots, for they rest on a base of greatly different and much less resistant material, the Cretaceous shales. Cretaceous rocks with relatively low resistance to Earth stresses, were strongly crumpled and folded during the period of overthrusting.

The Lewis Overthrust is exposed in a great number of places, but only a few are readily accessible for observation. I started my study at the Marias Pass exposure on Summit Mountain, in the southern end of the park (Figure 3). Here the exposure plainly belies the above quotation that the soft Cretaceous shales are folded and crumpled. Contact with the overlying Belt series shows a remarkably straight even surface. If this had in fact been a thrust plane, the soft Cretaceus shale would have been deformed, folded, even metamorphosed. But the Altyn limestone rests without apparent movement on the shale.

Contact between the Precambrian Belt Altyn and the overlying red Grinnell is another story however. There is a marked unconformity between the two formations. The Altyn has been eroded and gullied. Evidence of movement is not at the Belt-Cretaceous contact but rather between the Belt Altyn and Grinnell, which resulted in contact metamorphism. We were able to study this contact line at length.

Apparently the Altyn was laid down conformably upon the Cretaceous shale which appears as a straight, distinct line. Then the limestone was eroded before the Grinnell was laid down. But subsequently the Grinnell was disturbed with metamorphic movement which tore off slabs of Altyn and interfingered them with the Grinnell. There is evidence of local movement, but it is in the wrong place to uphold the overthrust concept, without which the evolutionary order of the fossils could be called in question.

Figure 5. Wynn Mountain, unconformity contact among members of Altyn dolomite, of Precambrian Belt Series of rocks. Cretaceous rocks do not appear here.

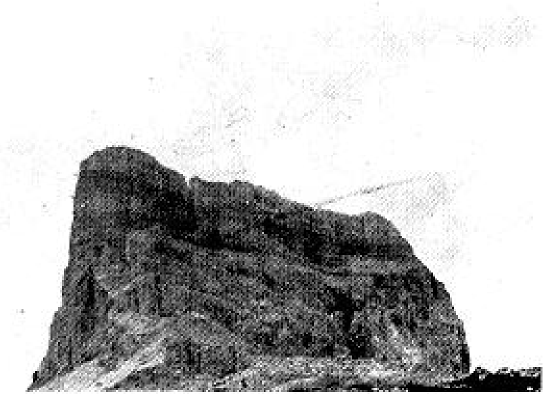

Figure 6. Chief Mountain, Glacier Park, Montana, composed of Altyn dolomite of Precambrian Belt Series. Unconformity near top of photo, where flat-lying Altyn dolomite overlies upright metamorphosed Altyn beds. At lower right corner small section of almost black Cretaceous shale appears. Unconformities lie within Belt Series rather than at contact with Cretaceous rocks.

At one point to the south of where we climbed the mountain I got a good view of the Cretaceous-Belt contact, which appeared as a sedimentary contact, with no evidence of movement.

Another very important structural feature is evident upon close observation. The Grinnell formation is flat-lying. The underlying Altyn limestone dips to the southwest at an angle of nearly 40 degrees. The adjustment between the two apparently caused the metamorphism. Strangely enough, the Altyn Precambrian and the Cretaceous shale are conformable, they dip at the same angle, thus needing no adjustment. Another indication of a sedimentary contact.

Wynn Mountain

I was informed that the Lewis Overthrust contact was in evidence on the southwestern face of the mountain in plain view of Many Glacier Hotel. As viewed from the resort the contact line runs down the mountain from left to right at an angle of about 15 degrees. Wynn Mountain is just south of Lake Sherburne along Canyon Creek.

When I arrived at the face of the cliff I found two contacts rather than one, one above another but neither one was a thrust-plane contact. They were in fact unconformities with angular discordance between the formations. Figures 4 and 5. The lower bed had been beveled off before the upper one had been deposited, but both appeared to be of the same Altyn limestone of the Belt series. Aerial photographs show up the faults around Wynn Mountain, but none crosses the mountain.

Chief Mountain

This is perhaps the most famous exposure of the Lewis Overthrust block, pictures of which have appeared in numerous texts on geology. It is a striking, majestic block of rock, standing alone, about 9,000 feet in height (Figure 6). Geologically it is considered an outlier or "klippe," or erosional remnant of the much larger Lewis thrust sheet, a mountain without roots, because Precambrian Altyn limestone and quartzite lie, apparently conformably, on top of Cretaceous dark shale. Much of the contact line is obliterated by talus, but where visible, it appears to be an **erosional contact,** without physical evidence of differential movement, such as gouge, mylonite, tectonic breccia or slickensides.

This prominent light-colored cliff lies a few miles south of the international boundary with Canada. The best approach to the mountain is by a road along Kennedy Creek, from where a steep climb awaits the prospector.

About two-thirds of the way up the mountain a sharp line of demarcation appears, which one at first glance might mistake for the thrust plane. On top of this plane are flat-lying Altyn Belt series Precambrian limestones. Below the contact are quartzite and deformed Altyn limestones. The quartzites denote metamorphism-movement under confining pressure; followed by erosion, and truncation of the rocks. The flat-lying Altyn beds were laid down on top of them.

Like Marias pass, the main tectonic activity shows up, not between the Precambrian Altyn and the Cretaceous shale, where the thrust-plane is supposed to exist, but within the members of the Altyn Formation itself. These evidences do not support the thrust-fault theory.

Roes Creek Contact

The contact at Roes Creek was easily seen and thoroughly identified by many scientifically trained persons. A section on page 18 in Dyson's work dealing specifically with the Roes Creek contact was used in verification:

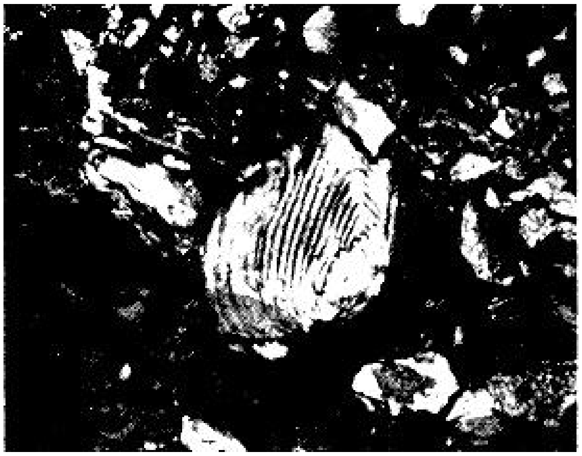

Figure 7. Veniella—a Cretaceous Pelecypod from Cretaceous shale at Roes Creek, below Precambrian Belt Series in Glacier Park. Burdick Photo.

Although the Lewis Overthrust is exposed in a great number of places, very few of these are easily accessible, and at only one does a trail provide a close approach to the actual contact between Belt and Cretaceous rocks. The latter site lies along Roes Creek only a few hundred yards from Rising Sun Campground. Before reaching the fault at the base of a high cliff of Altyn limestone, the trail crosses several outcrops of Cretaceous sandstone replete with fossil pelecypods (clams) and gastropod (snails).[5]

This was indeed the clearest exposure in all the park of a sharp contact between the overlying Altyn Belt Series, Precambrian limestone, or dolomite, and the underlying Cretaceous shale and sandstone. Cretaceous exposures were replete with fossils (Figure 7).

The relatively flat-lying Altyn limestone was lying atop the Cretaceous with not the slightest evidence of movement. The pieces of shale I dug from under the Altyn was compressed, but not deformed in any way as one would expect with a thrust fault or sliding plane. There was no gouge, mylonite, tectonic breccia, nor slickensides. The accompanying photographs illustrate this point (Figures 8, 9, and 10). This contact was alongside the path, which permitted close-up photographs of the exposure, and even enlarged photographs of the contact material.

Beyond all shadow of doubt, this contact was a sedimentary contact. Evidently identification of this contact as a thrust plane was made solely on the basis of fossil evidence with **total disregard** of physical evidence. However, Professor David Nelson informed me that he found a clam in the Altyn limestone. If so the classification of the Altyn as Precambrian may be in error also.

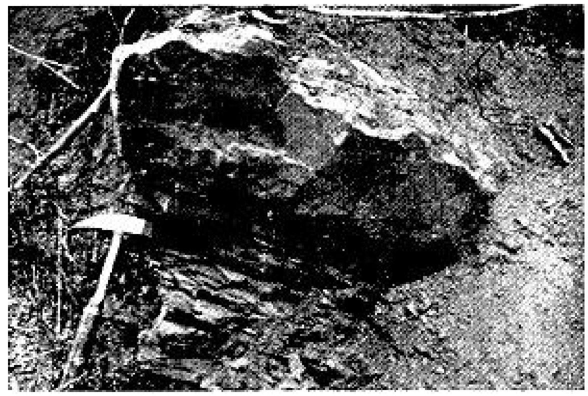

Figure 8. The Altyn dolomite, Belt Series Precambrian overlying Cretaceous shale beside Roes Creek, a few hundred yards from Going to the Sun Campground. Notice sharp contact, a depositional contact, at edge of hammer head; no signs of differential movement, or a thrust-plane. Since deposition, both formations have been tilted. No gouge, mylonite, powdered rock, tectonic breccia, or other evidence of thrusting.

Crowsnest Pass

Leaving the United States at Chief Mountain, or a little north of there, I headed into Canada, following the Rocky Mountains on the left, into Alberta, until I passed through a mining town of Franke, a coal mining settlement, with coal-bearing Cretaceous strata. The Precambrian limestones and quartzite overlying the Cretaceous sandstones and limestones are a part of the great Lewis Overthrust, hundreds of miles in length.

Franke was the site of a great tragedy some years back. A rockcreep on the face of the mountain developed into a landslide, and millions of tons of rock debris came roaring down across the coal mines and through part of the town, with the loss of many lives. A small earthquake may have loosened the slide. On the same cliff is outlined a small high-angle thrust fault.

The highway turns west across the continental divide into British Columbia, the pass being the dividing line between the provinces. At this pass is a beautiful exposure of the Lewis Overthrust, where the Precambrian Belt Series of rocks overly the Cretaceous limestones and sandstones. The contact line of the fault plane is tilted at a high angle from east to west, apparently the west limb of an anticline, indicating folding rather than thrusting (Figure 11).

Whenever pages of a notebook are folded, differential movement occurs between the leaves. Analogously, between the Cretaceous and the overlying Cambrian and Precambrian strata, evidently there has been differential movement, as evidenced by the two inch tectonic breccia layer. There is not enough of this as compared with the size of the formations, to indicate thrusting; no

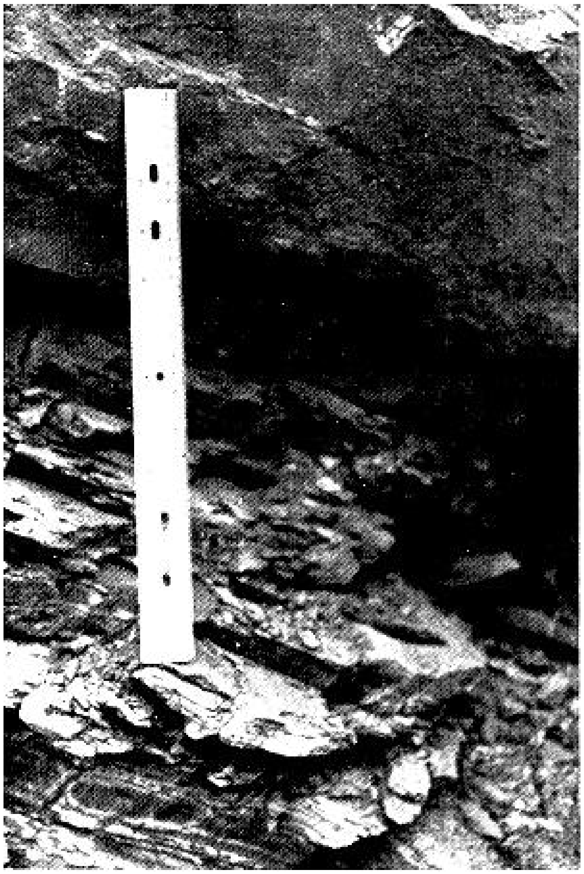

Figure 9. Apparent conformable contact (at seven and one-half inch mark), between overlying Altyn dolomite of Precambrian Belt Series, at Roes Creek, Glacier Park, Montana, and underlying Cretaceous shale. Clear-cut contact, with no evidence of movement, gouge, rock powder, mylonite, tectonic breccia, or slickensides. Underlying shale and sandstone contain Cretaceous shell fossils.

evidence of gouge (rock powder), mylonite (coarsely ground rock), or slickensides.

Crowsnest Mountain is the Canadian counterpart of Chief Mountain, with the strata slightly synclinal (like Eisenhower Mountain in Banff National Park). Crowsnest pass is one of the best places to study the so-called Lewis Overthrust contact, and provides some of the most positive evidences against the Lewis Overthrust concept.

Banff National Park

After traveling some 200 miles north of the international boundary I reached the city of Banff, one of the most beautifully situated cities in the world, nestled among such scenic peaks as Mount Rundle, Sulphur Mountain, and Cascade Mountain, with other snow-capped mountains like Assiniboine, Pilot Mountain, Eisenhower, Ishbel, Three Sisters, and Haiduk Mountains not far away.

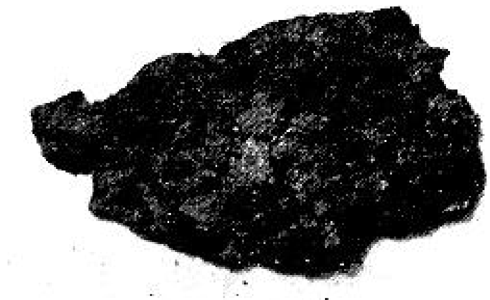

Figure 10. Close-up photo of the slab of Cretaceous shale underlying the Precambrian Belt Series Altyn dolomite. No signs of movement, such as gouge, mylonite (rock powder) tectonic breccia, or slickensides. There is evidence of intense compression however. This specimen was taken from the contact line.

Figure 11. Supposed Crowsnest Pass thrust-fault contact where Belt Series Precambrian rocks were believed to have been thrust over Cretaceous, coal-bearing limestone, near Franke, Alberta, Canada. The man and boy in the picture are at or on the contact. At the contact is a two inch thick line of tectonic breccia, evidence of movement, but is probably the result of folding. When one folds a telephone directory there is differential movement between all the leaves. The breccia line is too thin for giant thrust.

As one takes the lift to the top of Sulphur Mountain, he can get a beautiful panorama of glacially carved and chiseled snow-capped peaks in every direction, perhaps unrivaled on the North American continent, and certainly a worthy competitor of the Alps. From Sulphur Mountain one looks down on the city of Banff in the intermontaine valley formed by the Palliser Range on the east and the Continental Divide on the west.

Figure 12. Mount Eisenhower is a Precambrian syncline, with the west limb more steeply inclined than the eastern. The thrust contact is near the bottom of the picture. No close-up examination was made of the mountain, except at Ishbel Pass.

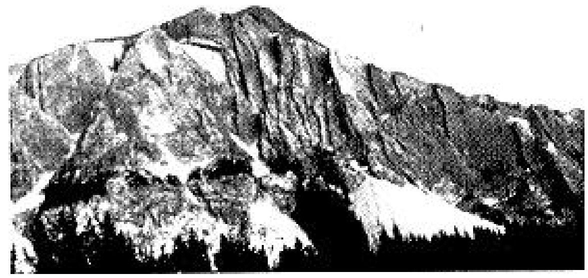

Figure 13. Mount Ishbel, showing strata tilted on edge, indicative of strong local uplift, probably the result of an intrusive pluton showing at right top of mountain. This intrusive may have been the cause of the pile of rubble on Ishbel Pass. Looking east.

Both ranges trend in a northwesterly direction and both dip, in places rather steeply to the west or southwest, suggesting block-faulting by normal or gravity faults, rather than low-angle or thrust-faults, as usually postulated. Such a conclusion is fortified by the presence of hot springs at Banff. Such springs require vertical or nearly vertical faults extending many miles down into the hot mantle or deep crust.

To present a basic picture of the geology of the area, I quote from *The Story of the Mountains in Banff National Park* by Helen Belyea:

> We must assume that enormous forces, of almost inconceivable magnitude, have acted slowly on these rocks over eons of time, pushing them up as though pushed from the west over the prairies to the east . . . forces acting on the rocks first push them into rolling arches and troughs, called respectively anticline and synclines. A syncline is seen on Mount Eisenhower. . . . Long continuation of pressure on the rocks eventually forces the arches over until they break, and the rock layers on top ride forward over the underlying layers. The planes along which the layers move are called thrust-faults, or simply thrusts. . . . The ancient rocks of Mount Eisenhower were thrust eastward over the much younger rocks in the valley between it and the Sawback Range.[6]
> (Mount Eisenhower is shown in Figure 12.)

The author here describes the folding of the strata due to compression from the west, deforming them into anticlines and synclines. This is apparently what happened, thus demonstrating such incompetence in the rocks that they will fold rather than submit to lateral translation as one stiff block over the many miles of terrain that the thrust hypothesis calls for.

In fact studies by Hubbert and Rubey,[7] have clearly shown that the crushing strength of granite would have been exceeded many times before a block the size of the Lewis thrust block could be translated so many miles. Folding, faulting, then chaos or rubble is the natural sequence, but the rocks at Crowsnest Pass, Mount Rundle and elsewhere show no crushing, and very little faulting, as one would expect from block-faulting, the kind of gravity or normal faulting that produced the hot springs.

Cascade Mountain, just north of Banff, is a typical arched anticline. The Sawback range or Mt. Ishbel shows strata on end (Figure 13), that is vertical, indicating compression all right, but also shows the incompetence of the rocks, unable to withstand the pressure necessary to push a great block *en toto,* across as many miles as usually postulated.

Individual blocks of rock have been observed to have been thrust up to half a mile without crumbling; but the larger the block, the greater the coefficient of friction, and the greater the compression required to overcome the friction. Thus crushing strength of the rock is soon surpassed. There is therefore a limiting factor as to the possible size of overthrust blocks.

Mount Eisenhower

Inasmuch as the Mount Rundle thrust-fault block was so close to town, I had expected to inspect the thrust-plane; however this seemed to be well covered with soil and rock debris. The strata dip to the west at an angle of some 30 degrees, and aside from block-faulting, there appeared to be no noticeable deformation. With block-faulting, that is normal faulting, one would expect that the fractures extended downward into the hot rock belt, where ground water would become heated and rise as hot springs.

Seeking the best visible exposure of the fault-plane, I checked the pass between Eisenhower

Figure 14. Mount Ishbel Pass, where piles of rubble resulted from eastward-dipping Ishbel strata moving against westward-dipping Eisenhower Mountain strata. This chaos is mute testimony against a continuous Lewis thrust sheet moving many miles eastward. The beds are not that competent. The motive force appears to have been a granitoid intrusion that tilted the Ishbel strata on edge. Mount Ishbel to the right.

Mountain and Mount Ishbel to the east. I parked my car in a meadow at the base of the pass, and followed a trail about three miles up a good grade to the pass.

To the west appeared the upturned abuttment of Mount Eisenhower where Johnson Creek had formed cliffs along the gorge. Along the pass were great piles of rock rubble, as if strata from the west had encountered movement from the east, and the result of these opposing movements was a mass of rubble. To the east the beds dipped to the east; to the west the Eisenhower beds dipped 5 to 10 degrees to west. If there had been thrusting, here was where an irresistible force met an immovable object.

Eisenhower Mountain, on the other hand, is a syncline (See Figure 12), the west end strata dipping east about 5 degrees and the east end dipping west about 10. This suggests folding and compression; if from the west, as the thrust theory advocates, then the immovable object was Ishbel Mountain, where the strata are nearly vertical. The thrust would have been stopped there if there had been a thrust, or if only folding, then either the folding was stopped there, or it uplifted the strata of Ishbel until they stood on edge. In either case the evidence demonstrated the incompetence of the rock strata to thrust as a block over the distance postulated.

The chaos of rock debris at the pass (Figure 14) suggests that the rock was not competent enough to have tilted the strata of Mount Ishbel on edge; a plutonic intrusion may have done that–in fact I did find granitoid float along Johnson Creek. In place of overthrusting, the folding of the strata that formed the syncline at Eisenhower Mountain tilted the east dipping beds toward Ishbel Mountain to about 20 degrees. It is very possible that the granitoid intrusion at Ishbel not only tilted the Ishbel strata on edge, but pushing westward made a slight synclinal fold at Eisenhower Mountain, then the rocks crumbled at the pass and left a pile of rubble.

Conclusion

There are of course other relatively inaccessible thrust contact exposures which were not observed; however I believe that sufficient evidence was gathered from the several exposures that we studied, to throw grave doubt upon the whole overthrust theory when applied to the giant overthrusts, such as the Lewis, Bannock, Moine, and some in the Alps.

As pointed out by Burdick and Slusher in the paper mentioned above, it is relatively simple to distinguish between actual overthrusts and paleontological ones, because the true overthrusts show physical evidences of thrusting, such as gouge (rock powder), mylonite (less finely ground rock), tectonic breccia, and slickensides (similar to glacial stria). On two such thrusts in Arizona such physical evidence was found, but on the Lewis Overthrust exposures I was unable to find any such evidence.

One cannot easily dismiss the evidence that some of the giant so-called overthrusts may in fact be based merely on the order of the fossils. Engineering studies have already thrown great question marks around the large thrusting concept. I will always remember an offhand remark made by a structural geologist in a graduate class at the University of Wisconsin: "I often wonder what giant lubricator greased the underlying rocks, that enabled the thrust block to overcome the friction and slide over several miles of rock terrain?"

Evidently at least one structural geologist was somewhat less than convinced, as have been many a structural geologist since, until Hubbert and Ruby showed the impossibility of such an hypothesis.[8] Of course they tried to substitute the theory of *pore water pressure* – the theory being that the ground water in the pores of the rock would tend to buoy up the thrust block, thus reducing the friction or drag. However, dense rock with a specific gravity of 2.75 has never been known to float in water, with a specific gravity of one. The theory has not been widely accepted*.

*Since I wrote this paragraph, an excellent paper has been published in the June, 1969 issue of the *Bulletin of the Geological Society of America,* pp. 927-952, by K. Jinghwa Hsu of the Geological Institute, Swiss Federal Institute of Technology, Zurich, Switzerland. Hsu claims that Hubbert and Rubey overlooked the *coefficient of cohesion* between blocks of a thrust. This would make giant thrusts untenable. Hsu writes, "An increase of pore pressure alone reduces only the internal friction but not the cohesive strength as shown clearly by the experiments of Handin and associates." (Handin, John, R. V. Hager, Melvin Friedman, and J. N. Feather. 1963. Experimental deformation of sedimentary rocks under confining pressure; pore pressure tests. *American Association of Petroleum Geologists, Bulletin,* 47:717-755.) Thus a "roadblock" has been thrown up apparently against the hypothesis of large overthrust blocks.—Burdick.

Some may object by asking, how many, many professional geologists could have been mistaken so long on such a major structural phenomenon as the Lewis Overthrust? The answer is not simple; one must have felt the geologic "pulse" until he knows it like a physician; then he will not longer be surprised when authorities differ on geological propositions. David B. Kitts[9] well expresses the situation when he says: "The view is not uncommon among geologists, that geology is as much an 'art' as a science. . . . The employment of many seemingly statistical and probabilistic generalizations imparts to geology an aspect of **'indeterminacy'."** (Uncertainty).

A generation or so ago paleontologists and stratigraphers pronounced this large area of "wrong order" fossils, an overthrust. Later geologists have regarded their pronouncement so sacrosanct that scarcely anyone questioned the concept. But now at long last some geologists are taking a new, hard look and finding a basic misconception in earlier speculations; namely, the theory of the invariable evolutionary sequence of fossils throughout the geological ages.

In referring to the Heart Mountain thrust faults of Wyoming, Hubbert and Rubey[10] remark that the "picture of fault blocks, separated in some as yet undetermined manner, with the fault plane exposed only briefly in the areas between the fault blocks, seems fantastic if not impossible."

References

[1]Nicholson, Henry Alleyne. 1897. Ancient life history of the earth. D. Appleton Co., New York, N. Y. p. 40.

[2]Billings, Marland P. 1955. Structural geology. Prentice--Hall, New York. p. 151.

[3]Burdick, Clifford L. and Harold Slusher. 1969. The Empire Mountains–A thrust fault?, *Creation Research Society Annual,* 6:49-54.

[4]Dyson, James L. 1967. The geologic story of glacier national park. Glacier Natural History Association, Kalispel, Montana, p. 14.

[5]*Ibid.,* p. 18.

[6]Belyea, Helen R. 1967. The story of the mountains in Banff national park. The Geological Survey of Canada, Ottawa. p. 12.

[7]Hubbert, M. King, and William Rubey. 1959. The mechanics of overthrusting, *Bulletin of the Geological Society of America.* pp. 185-200.

[8]*Ibid.,* pp. 185-200.

[9]Kitts, David B. 1964. The theory of geology (in) The fabric of geology. Edited by Claude C. Albritton, Jr. Geological Society of America. Freeman, Cooper and Co. Stanford, California.

[10]Hubbert, M. King, and William Rubey. 1965. Role of fluid pressure in mechanics of overthrust faulting. *Bulletin of the Geological Society of America.* p. 470.

COMMENTS ON SCIENTIFIC NEWS AND VIEWS

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Theistic Evolution and Stories

Those who wish to subscribe to the doctrine of theistic evolution (which, to put it bluntly, is the doctrine that the world evolved, and God sat and watched it happen), often dismiss the account of creation in Genesis.

Some claim that Genesis is written as it is to benefit those to whom it was originally given, and that the people at that time could not have received the evolutionary account. But surely such a statement is nonsense.

Suppose that the account given to the ancient Hebrews had told them that in the beginning, a long time ago, God made the world, and then He made some small creeping things, and these turned into fish, and the fish turned into large creeping things, and those turned into beasts, etc.? What evidence is there that people would have found it difficult to accept such a story? Other ancient people accepted more improbable stories.

Consider, for instance, the Greek stories in which Ulysses' men were turned into swine, and other stories in which people were turned into birds, or the Greek story of how the world was re-peopled after the Flood. (Incidentally, does anyone know how the Greeks supposed the world to have been "re-animaled after the Flood?) Apparently the Greeks had no trouble in accepting these stories, at least until the time of the critical philosophers.

And we find accounts of other weird and wonderful transformations among other ancient people, and among primitive people to this day. (It might be remarked, though, that Aristotle, in another connection, saw the absurdity of the supposed transformations; he said that to suppose

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