

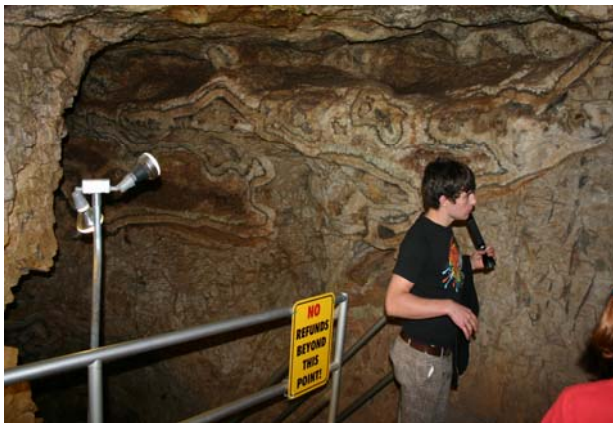
Sealed door entrance (outside the bottom of an elevator) at Wind Cave, South Dakota. Note how a section of cave ceiling has been incorporated into the infrastructure. Wonderful interpretation opportunities here!



NORTH AMERICAN WANDERINGS

*Take me back to the Black Hills,
the Black Hills of Dakota,
the beautiful Indian country that I love...*

– Kent Henderson



Our young guide inside Sitting Bull Crystal Cavern. Note the new aluminum railing, and the sign which says 'No refunds beyond this point'. A lack of management confidence, perhaps...?

During a recent trip across Canada in September, I zapped south of the border into the USA, specifically to South Dakota, to check out the local limestone. The main karst area of South Dakota (which is in the south-west corner of the State) surrounds, literally, the famous Black Hills, home of the Mount Rushmore National Monument – which probably most people have at least heard of.

The Black Hills (which are decidedly grey...) are volcanic. They were actually so-named because the

trees look black when the hills are viewed from out on the prairie. The native Lakota word for the Black Hills is *Paha Sapa* (which literally means 'Hills Black'). Geologically they are a volcanic intrusion through the centre of a large limestone plain, when the Hills were uplifted about 60 million years ago, cracking the surrounding limestone and largely forming the caves in the process. Today, the karst exists as an almost continuous ring around the hills in the centre (see Figure 1, below).

There are six show caves in South Dakota – two publicly-owned, and four privately-owned. In my two (very!) full days in the area, I got to them all (as I would)!

Upon leaving Rapid City (a city of circa 80,000 to the north-east of the Black Hills), I motored first to Sitting Bull Crystal Caverns located only nine miles to the South. This cave was discovered in 1876, and explored, developed and opened as a show cave by Alex and Mamie Duhamel in 1930. It has been continuously owned by the Duhamel family since. The name 'Sitting Bull' is simply a commercial exploitation of the name of a well-known historical figure – certainly Sitting Bull, the great Sioux Indian chief, has no provable connection with cave. Based on anecdotes received, I was not expecting much of the privately-owned caves I was to visit, and generally my expectations were not to be exceeded – although Sitting Bull Crystal Caverns was to prove a little bit of an exception.

Dog-tooth spar in Sitting Bull Crystal Cavern (plus considerable lampenflora...)



The Wonderland Cave Ticket Office and shop



I rolled up, walked through the obligatory shop full of kitsch, and met my young guide at the cave entrance. Privately-owned caves in America largely employ 'juniors' as guides, as it clearly costs less to hire them. As a result, guides tend to be on their 'first job' and largely their longevity as such is not extensive.... As for training, I did not observe that any great heights had been reached, to say the least...

So, our obligatory young guide led my tour group down a very long stepped descent into the cave. I was pleasantly surprised with the quality of the infrastructure. The many handrails were recently-installed extruded aluminum, the steps modern messed steel, and pathways well formed of raised messed steel or concreted. And the cave itself? In a word, pretty stunning! Its decoration is almost entirely dog-tooth spar crystals. And they are,

mostly, huge! Most average about thirty centimeters in length, with some approaching half a metre long. Most impressive.

Unfortunately, the big minus was no switching to the (powerful...) lighting. As to be expected when lights are on all day, *lampenflora* (algae to the Americans...) was rampant. As is the 'American way', they claim to have the longest (biggest, best...) dog-tooth spar of any show cave in the world, and in this case, probably uniquely, they may well be right. As for my young guide...well...he tried hard. We were 'blessed' with the *French Chandelier Room*, *Diamond Lake*, *Rainbow Arch* – you get the picture.



Exposed conduit in Wonderland Cave

I next ventured to Wonderland Cave (a complete misnomer...), about half an hour north of Rapid City. This is the only South Dakota show cave that is not in the limestone ring around the Black Hills.

It was discovered in 1880, and opened in 1929 – but in my view should have been left firmly shut. One leaves the obligatory kitsch shop for a short walk to the cave entrance.

I was deeply unimpressed with the cave, to say the least. My guide was, perhaps, fifteen years old. Not surprisingly, his cave knowledge was sparse and that is being kind. Upon entering, one arrives in a relatively low medium-sized chamber largely devoid of decoration. A stairway/passage has been excavated in the middle of this chamber leading to a circuitous route below.



A 'modicum' (!!!) of parafloods in Wonderland Cave

This lower section has been totally excavated through the cave floor and sediments, destroying much in the process – certainly without the excavation the bottom section could not be toured (the actual height of the area overall, prior to excavation, would not exceed about 1.5 metres...). The decoration is sparse and unexciting.

The infrastructure is appalling – it appeared to me that the minimum amount had been spent to get the cave open. Conduit flows freely everywhere it shouldn't, and the lighting is basically strung light globes at intervals. No track work of any distinction has been undertaken, and steps and handrails, where they exist, are old wood or rusting ironwork. *Lampenflora* is endemic, with luscious fern growth at many light fittings. There is absolutely nothing wonderland about this cave. Of course, like many privately-owned caves in America, it is a cash cow for the owners (they hope...), and spending money on infrastructure will clearly affect profits. Obvious, isn't it?



'Stunningly beautiful' fern growth near a light fitting in Wonderland Cave...

Kent Henderson with guide Matt Chalk in the Black Hills Cavern shop



On leaving the forgettable Wonderland Cave, I next ventured back towards Rapid City to Black Hills Caverns. You would kill for its location, only seven kilometres west of the city. The cave is a series of moderate sized chambers, with a reasonable array of decoration, and the infrastructure is passable, but not such as we'd consider acceptable in Australia or New Zealand. Two tours are offered, the hour-long 'adventure tour' (i.e: the whole show cave), or the thirty minute 'crystal tour' (largely designed for seniors). Features of the cave include some nice boxwork, and particularly its *popcorn* crystal.



The Visitor Centre at Rushmore Cave

After Wonderland Cave, my expectations for the guide were not great, but I was pleasantly surprised. My host here was senior guide, Matt Chalk. He has (unusually) been a guide for seven years. He loves caves, and clearly has a genuine interest – that came across. He is very much self-taught from his own readings, and his tour was quite good – mostly avoiding the *fairy castle syndrome*. He is hopeful of getting to Australia at some stage, and if he turned up here looking for a casual guiding job, he would certainly have my recommendation.

My next cave visit was to Beautiful Rushmore Cave (beautiful is part of the cave title...), which is quite close to the Mount Rushmore National Monument (which I also briefly visited – okay if you like carved granite and are a true American patriot...).

The Mount Rushmore National Monument



Rushmore Cave was mildly interestingly, and its development tolerable. It was discovered by miners in 1876 (and duly mined to some extent), and developed and opened in 1927. The initial chambers, given its history, are largely devoid of decoration. However, the final section (*The Big Room*) is quite a large chamber, and contains a good array of speleothem development – but nothing particularly outstanding. This section was discovered in more modern times, and thus largely its speleothems had not been substantially taken as ‘souvenirs’. The cave infrastructure is ‘okay’ – pathways are well formed, with galvanized iron railing and steps. Interestingly, a quite lengthy exit tunnel was mined out in more recent times – both the entrance and exit are from and to the obligatory gift shop. The guiding – at least in this case not by a child – was unexceptional; the usual *fairy cake* fare.

As with all caves I’d visited thus far, Rushmore Cave was largely devoid of switching, with lights (usually very bright parafloods) on all the time. Of course, as a result, the cave contained almost as much green decoration as any other... Sigh... Overall, it was better than some, but hardly top drawer.



Rod Horrocks at one of the entrances to Wind Cave

On my second, and last, day in the area, it was treat time! I motored off to the fabulous Wind Cave. The cave specialist there is Rod Horrocks, who is also President of the National Speleological Society Cave and Karst Management Section (sort of the USA ACKMA... our two organisations are cross-affiliated). It was great to meet Rod and pass on the regards of several cave personages of his

acquaintance, particularly Elery Hamilton-Smith and Neil Kell (Neil spent considerable time with Rod during his Churchill Fellowship tour in the USA some years back).

Wind Cave and Jewel Cave (the latter of which I visited that afternoon, more below) are run by the USA Forest Service (hallelujah...). The first recorded discovery of Wind Cave was in 1881, and it was opened to the public soon after. It became public property in 1901, and in 1902 the cave became a National Park (the 7th in the USA, and the first cave site so designated).

Upon arrival, I alighted at the expansive *Wind Cave Visitor Centre* – which contains extensive and impressive interpretive displays, and sort out Rod. After an extensive chat in his office, he kindly spent a good part of his morning giving me a personal guided tour.



Rod Horrocks at wonderful interpretive signage in the Wind Cave Visitor’s Centre

Where to start? The first thing to appreciate is that over 126 miles (202 km) of passage have been surveyed in Wind Cave, making it one of the longest cave systems in the world. Given the air flow at the cave entrance, it is estimated that 95% of the cave remains undiscovered! Of course, exploration in ongoing – probably ‘forever’. The Air flow from (into...) Wind Cave is massive. Guides often have to push hard to open the sealed door entrances. The next thing to appreciate is that Wind is a massive maze cave with literally hundreds of intertwined passages. The cave is relatively shallow – in limestone, dolomite and gypsum – with a many paleokarst intrusions.

The speleogenesis of the cave is fascinating. The earliest cave passages are considered to be pretty much nearly as old as the limestone itself (350 million years). The limestone deposited on the then sea floor of the area contained large amounts of intermingled gypsum. Chemical breakdown of the gypsum produced sulfuric acid, which dissolved small caves and pockets in the limestone. Dissolving and recrystallising of the gypsum created cracks in the surrounding limestone, many of which refilled with gypsum. As freshwater seeped through the rock, this gypsum dissolved and was replaced with calcite. The small openings produced by these natural processes represent the birth of Wind Cave.

Incredible boxwork in Wind Cave, South Dakota



For about 300 million years, a series of seas alternately covered the land and then receded. When the land was exposed, freshwater found its way into the cave dissolving the rock and enlarging the existing cave passageways. Sediments from these later seas washed into the cave creating the reddish-brown paleofills seen along cave tour routes today.

Cave formation accelerated when the Black Hills were uplifted about 60 million years ago. This uplift caused existing cracks in the sedimentary rocks to enlarge and new cracks to form. Underground water was then able to move more freely through the limestone but was unable to drain out. This allowed standing acidic water to dissolve the limestone and dolomite uniformly along the existing fractures, enlarging the cave. Some 40 to 50 million years ago outlets for the water developed and the cave drained. Today, the water table is about 500 feet below the surface.

The other interesting feature of the cave is that is largely overlaid with sandstone. Consequently, little surface water reaches the cave, and it is therefore largely devoid of 'normal' speleothem development (though there are bits of good stuff).

The fame of Wind Cave is in its incredible boxwork. This rare type of speleothem occurs in great profusion throughout much of the cave, especially in the dolomite of the middle and lower levels. These thin fins of calcite, resembling honeycombs or open-ended boxes, protrude from cave walls

and ceilings. Boxwork is composed of calcite formed in cracks by the breakdown of gypsum before the cave existed. Naturally produced hydrogen sulfide and sulfuric acid caused the dolomite between the calcite veins to be crumbly, allowing water to move easily and dissolve the weathered rock from between and around the boxwork fins, leaving them standing out in relief. Amazing stuff.

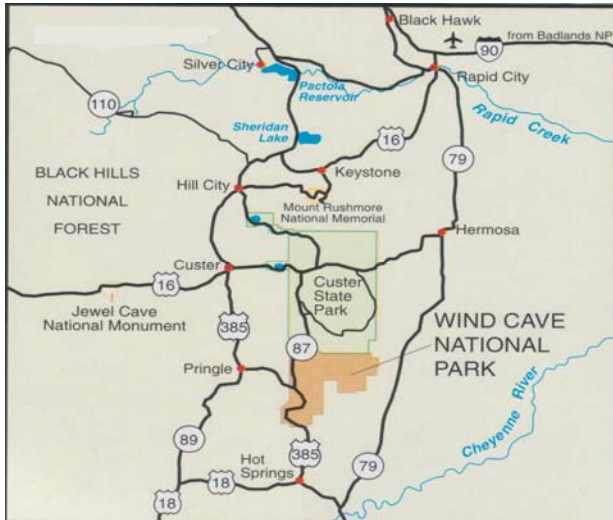


Visitor seating in Wind Cave
– a good idea give the length of the tour!

Wind Cave is very well developed and managed. There are two used entrances, one being an elevator excavated to the various levels of the cave. The pathways are largely well-formed concrete, and the handrails are recently installed stainless steel.

The lighting in the cave, however, could use more switching in my view, but *lampenflora* appears very largely under control. Happily, the re-lighting project will begin about December 2007, and it will feature significant switching.

A locality map of Wind Cave and Jewel Cave



As just noted the re-lighting of the cave is imminent – not a desperate need, but certainly updating is desirable. However, the US Park Service is not without its politics... While Rod is the cave specialist, he is not the cave manager *per se*, and management has certain ideas for re-lighting, while Rod has others... It is not hard to guess whose will be better, but Rod has little say as to the infrastructural development of the cave. Not good, but that's how it is.

Rod, one of the USA's premier cave and karst management experts, is regularly called on to advise all over America and wider a field, yet he is regularly 'taken for granted' on his own patch – a sorry story which is certainly not unique, sadly..... Still, overall, Wind Cave would comfortably fit into the Australian and New Zealand pantheon of well-developed and well-managed caves. Let us hope it stays that way....

Upon leaving Rod with my grateful thanks, I motored onto Jewel Cave National Monument; about thirty minutes drive away, via the lovely 'old west' town of Custer (where I was staying).



Our tour party in Jewel Cave – note the excellent infrastructure

So you thought Wind Cave was a tad big...? At 140 miles, Jewel Cave is the second longest cave in the world. From 5–7 October 2007 cavers spent 62 hours underground and discovered a further 3,044 feet of cave passage....

The Visitor's Centre at Jewel Cave is considerably less extensive that at Wind Cave (yet still first-rate!), but it does have a good audio-visual room playing an excellent DVD on the cave. The speleogenesis of the two caves is not dissimilar, although Jewel is not nearly as maze-like as Wind, and it also features a number of substantially-sized chambers.

I went on a regular guided tour. The current entrance is via a deep elevator. Upon alighting and passing through a sealed door, one enters a quite large initial chamber. The guide I had, I must say, was rather unctuous, and she had the terrible habit of repeating every question she was asked. That said, I couldn't fault her interpretive knowledge (if not her 'school ma'am' self-righteous style).

And what of the cave? Particularly stunning! The infrastructure was excellent, as one would expect, and the illumination did have feature-light switching (but probably not enough). Like Wind, Jewel has a largely non-porous overburden, so speleothem development is not voluminous – although Jewel has considerably more than Wind. It does possess boxwork, although not nearly to the extent of its sister cave. Nailhead spar is a particular feature, as well as dog-tooth spar, and wonderful helictite and gypsum decoration.



The entrance to Crystal Cave

On leaving Jewel Cave I rushed back towards Rapid City to visit my final target, Crystal Cave, which is just 'up the road' from Black Hills Caverns. I just made the last tour of the day. It was discovered in 1880, and opened in 1929 under its original name of 'Nameless Cave'. No comment.

It is a relatively short stream passage cave of easy traverse, and it is quite highly decorated in parts. The tour lasted about forty minutes (in and out the same way). The range of its speleothem development is a feature – it boasts sixteen different types, but I didn't bother count... As well as the expected decoration, it contains some boxwork, popcorn crystal and excellent dogtooth spar. In short, it was not the most uninteresting cave in the area, but hardly unforgettable.

The mirror in Crystal Cave



The infrastructure of the cave is ordinary – pathways of compacted sediments and iron handrails, no switching and expansive *lampenflora*. The guide (not a teenager) was adequate, and appeared to have a genuine interest in the cave, although his knowledge of fairy castles was more in evidence than his history and geology...

Two things about the cave were, to me, interesting. Firstly, there was a large mirror placed at 45 degrees to show decoration around a corner which could not be viewed otherwise – I thought that was quite innovative, and I do not recall seeing similar elsewhere. Secondly, the skeleton of an indigenous person found in the cave some years ago (and duly removed to the Smithsonian...) was interesting. A cast of the skull has been placed at the discovery spot, providing a useful interpretative tool.



The skull in Crystal Cave

And thus I left South Dakota – a very pleasant part of the world indeed.

Back in Canada, during my travels, I spent two days driving around the Canadian Rockies, truly a sight to behold – majestic mountains, lots of glaciers, and mostly karst! Indeed, mountains of karst, and heaps of caves. Interestingly though, no show caves, which I thought was strange given the very close proximity of large cities such as Calgary and Edmonton.

That said there was one sort-of show cave. Just out of Banff (indeed effectively in the 'suburbs') is *The Cave and Basin* National Historic Site. The local geology is of limestone overlaying volcanics, and the cave (as with a few others in the area) is a volcanic vent that intruded out through the karst – quite interesting.



The heavily-modified cave vent at The Cave & Basin



'The Basin' at The Cave and Basin – note the tufa at the rear of the scene. Tiny endemic snails live on the flotsam in the water.

The cave/vent is quite small. Passing through the substantial Visitor's Centre, one enters a short concrete tunnel, arriving at a smallish chamber, with a 'hot water' pool at the base, and surface vent at the top.

The whole scene has been heavily modified with stone walls around the pool. Outside, near the Visitor's Centre, is *The Basin*, a thermal pool which was once a popular swimming hole. Swimming has long since been banned, as the pool is the home (one of few...) of an endemic (and endangered) species of tiny snail.



The entrance to The Cave & Basin Visitor's Centre

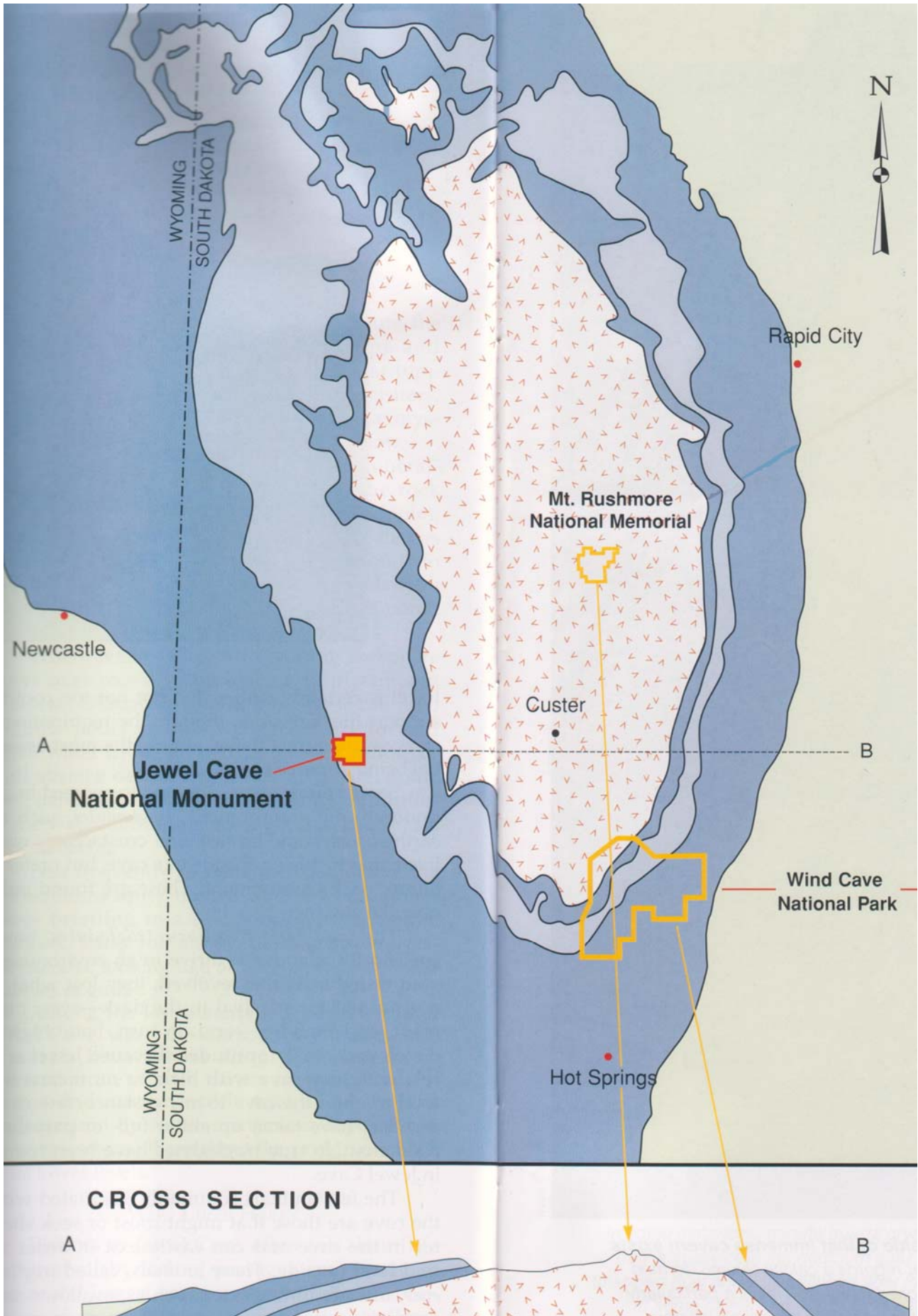


Figure 1. Diagram & cross section of the Black Hills of Dakota, showing the encircling limestone belt