Economic Geology of Iowa

Benton County

Nolan Sagan

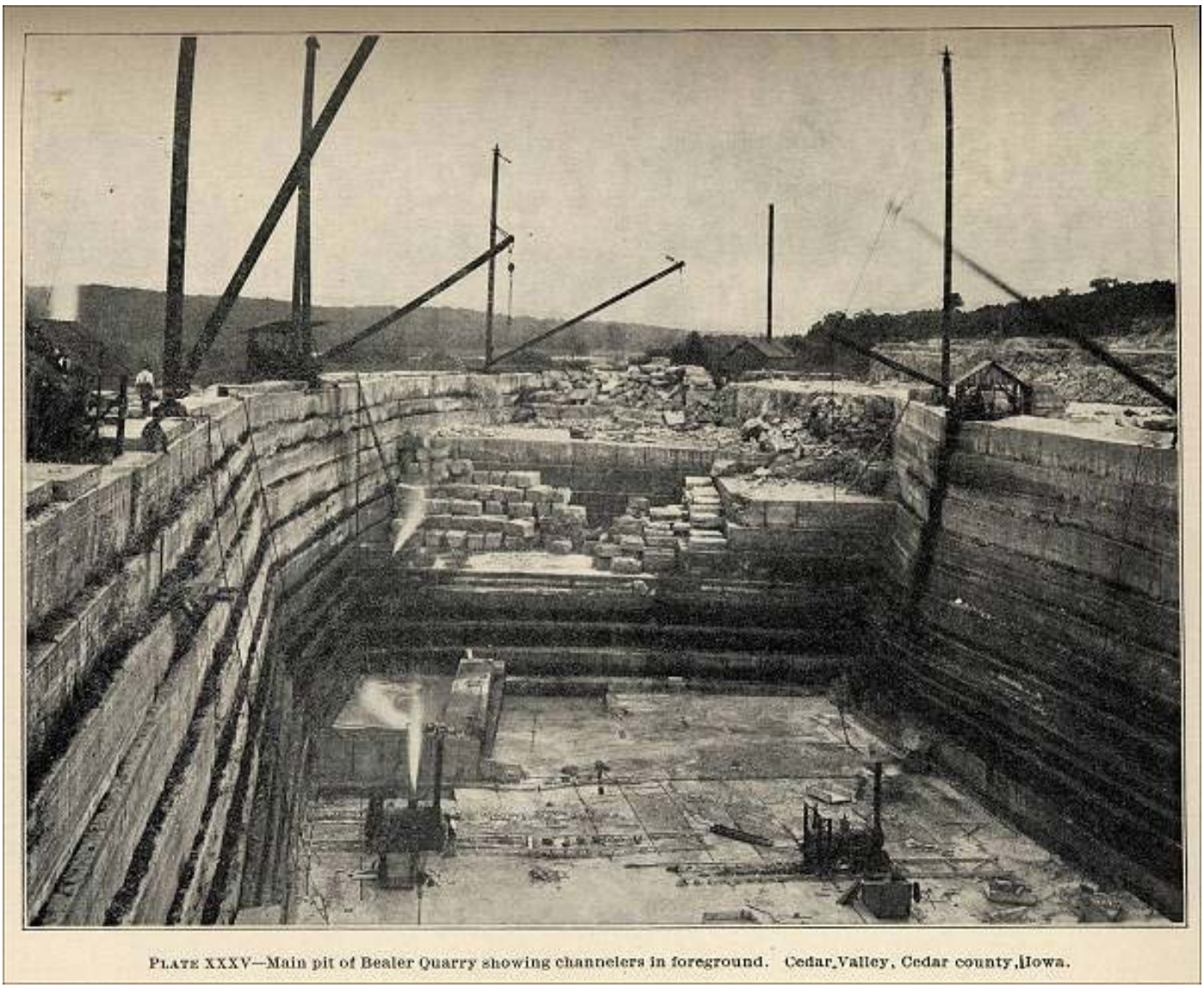

PLATE XXXV—Main pit of Bealer Quarry showing channelers in foreground. Cedar Valley, Cedar county, Iowa.

Signature Page

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Dr. Chad Heinzel

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Abstract

The economic geology of benton county is a long and very interesting story. From the corn and soybean fields, to the cedar river, to the quarries, Benton county has much to provide not just to the state of Iowa, but the United States of America. First I will cover the overall geology of the entire state of Iowa and then focus in on the area I was raised in, Benton county, then I will explore the vast resources Benton county has to offer. Economic geology has had more of an impact on all of us than we will ever understand. Literally every material possession we own came from the earth whether directly (raw minerals) or indirectly (plant material for example). The more we understand economic geology the better we can utilize it in the most efficient way possible. Nonrenewable resources are named accordingly because there is a finite amount on our planet. If we do not learn how to be as efficient as possible with these resources the consequences could be detrimental in the future. Although the soil under our feet in Iowa is extremely fertile, that fertility will not last forever especially with the extreme stress we put on it. The goal of this paper is to bring to light the immense impact Benton county has on economics not only in the agricultural industry, but in the aggregate industry as well.

Introduction

Although Iowa does not have the reputation for beautiful geography as other locations around the world, Iowa's geologic past is very interesting and is worth learning about. From the variation of bedrock compositions to the numerous surface features, Iowa has much to offer in the realm of geology. A reason geology is so interesting is that it is always changing. We learn about past geologic processes from the ones occurring in our world today. This knowledge will have a major economic impact on the future of mining in our state. Because our geologic world is always changing, I hope to accomplish a similar feat as our textbook author and Earth Science program founder Wayne Anderson, to present "A snapshot of what geologists currently know about the state's fascinating geologic past."

It was spring 1839; George Wright and John Smith were searching for a good place to settle when traveling west and they chose the canton township in Benton county Iowa.These were the first of slow increase of population through the 1840's to settle Benton County. AS seen in figure 1 Benton County is located in east-central Iowa directly south of Blackhawk County. It is in the heart of the cedar valley, with the Cedar River running through the northeast part of the county including through the county's capital, Vinton, IA. Vinton alone accounts for about twenty-five percent of Benton County's population of twenty-six thousand. The primary school district is the Vinton-Shellsburg School District, including the county's two biggest towns, and various other small towns as well.

Benton County in Respect to the State of Iowa

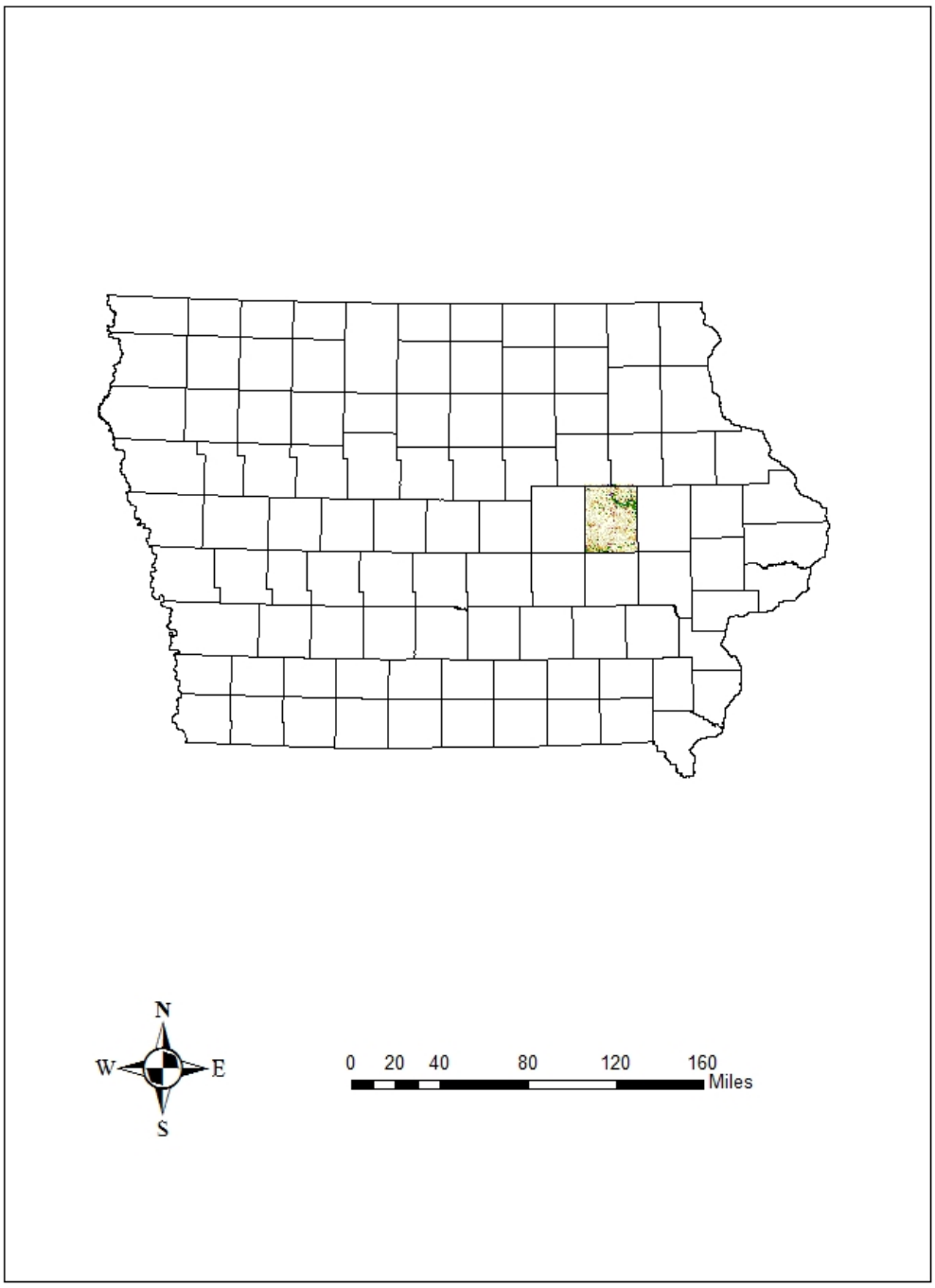

Figure 1

Geology of Iowa- Precambrian and Cambrian

Iowa unfortunately does not contain an extensive collection of Precambrian geology. As seen in figure 3, the only instance of this as an outcrop is in the northwest corner of the state, which is about five hours from Benton County. This is known as the Sioux quartzite found in the Gitchie Manitou State Preserve. This 1.6 billion year old rock is the oldest surface outcrop in Iowa. This instance of quartzite also extends into South Dakota and Minnesota. The Sioux quartzite has been quarried extensively for multiple reasons. It is a very highly metamorphosed rock, resulting in grains extremely well cemented together by silicon dioxide. So well cemented, in fact, that it will fracture across the grain sooner than around it (W. Anderson 1998). This makes the Sioux quartzite a very valuable construction material and it was even utilized in some of our buildings around campus.

Much like the Precambrian, the Cambrian is defined on the surface by only a small outcropping. This occurs in the very northeastern corner of the state approximately two hours from Benton County. The explosion of life into this world defines the Cambrian time period. This is often associated with trilobites, as they are the most commonly preserved specimens from the Precambrian. But, because most of Iowa was in an inter-tidal zone at the time, most of the would-be fossils were destroyed by waves.

Iowa's Cambrian is characterized mostly by a formation known as the Jordan Sandstone. This well-rounded, well-sorted sandstone serves a very important economic necessity for almost the entire state of Iowa. The maturity of the sandstone resulted in very high permeability and porosity of the formation making it the perfect aquifer. Over one hundred and fifty wells across the state have been drilled into the Jordan sandstone including five in Benton County alone.

Bedrock Geology of Iowa

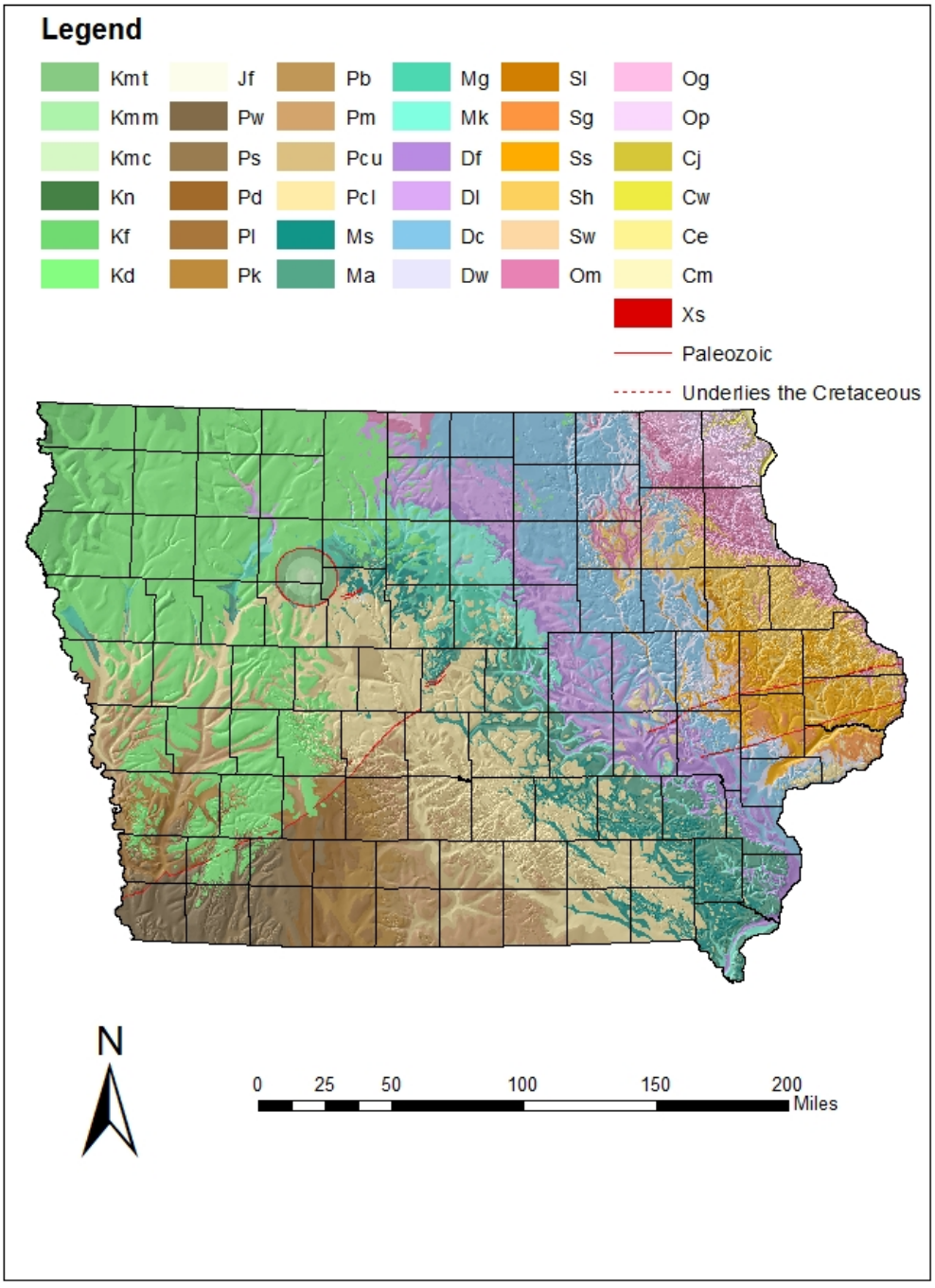

Figure 3

Figure 6 shows all the wells drilled into the Jordan sandstone as well as the extent of the formation across the state (Libra 2002).

· With this many wells drilled, one could infer that the level of the aquifer is at risk. While in many areas the level of water has not been affected in a major way, there are instances in which the water level is in danger, dropping over one hundred feet from pre-well figures. There is still plenty of fresh, clean water left in the Jordan sandstone and without it, much of Iowa would be left looking for an alternative source of drinkable water.

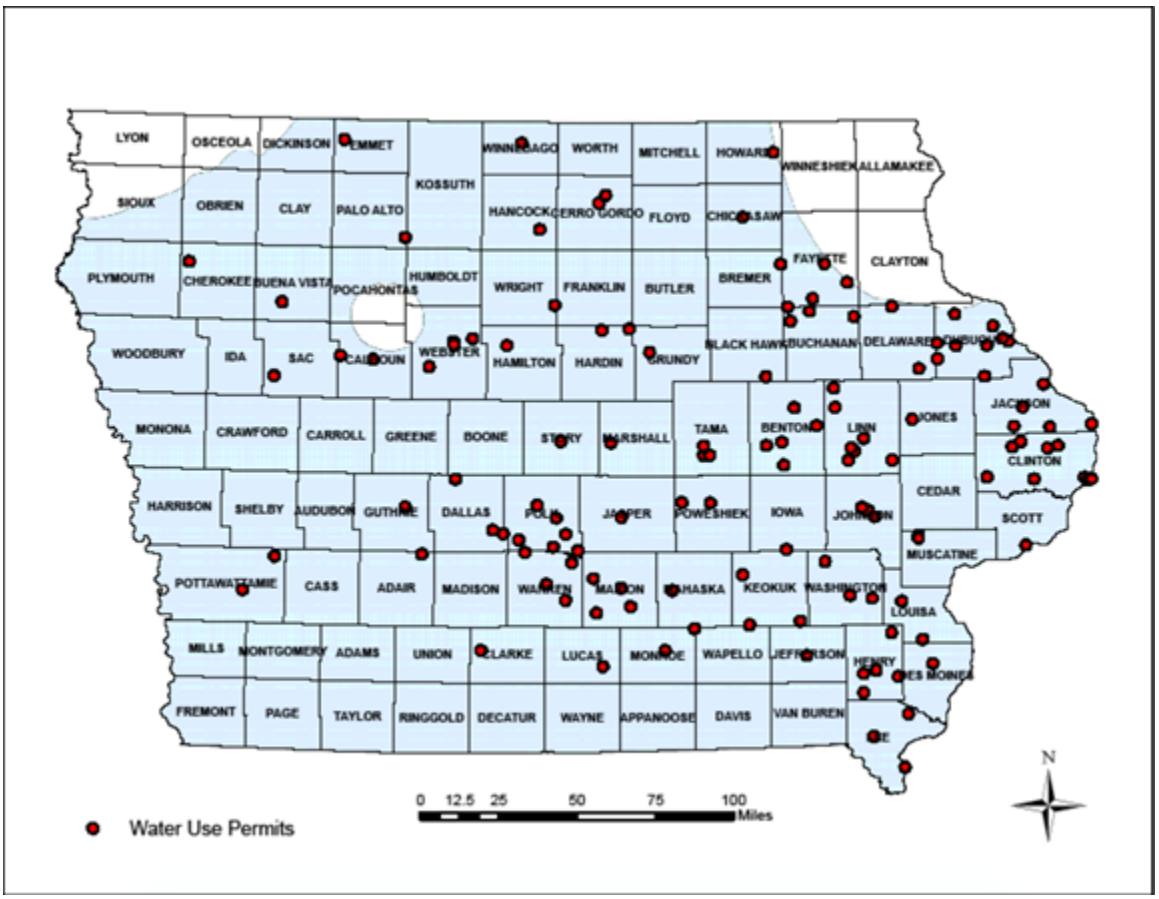

Figure 6

Geology of Iowa- Ordovician

· The majority of Iowa's Ordovician bedrock is concentrated in the northeastern section of the state with small outcroppings in Winnebago and Clay counties, in north-central Iowa. Five formations make up the entirety of the Ordovician in Iowa along with a formidable unconformity. From old to young, the Prairie du Chien group is first, followed by the unconformity, then the St. Peter formation, followed by the Platteville, Galena, and Maquoketa formations. Of these, the most economically valuable would be the St. Peter formation. Made up mostly of well–sorted quartz sand, this formation is currently being mined in various locations across the state. This quartz was eroded from the exposed Precambrian outcroppings of the transcontinental arch and Canadian Shield sandstones.

The shallow marine setting of the Prairie Du Chien group and other formations in the lower Ordovician resulted in an abundance of oolites and stromatolites. Oolites are sand-sized bodies with laminations of calcium carbonate. They are formed by continually adding layers of carbonate onto a very small particle that is being rolled around the seafloor by wave energy. The result are sub spherical grain-sized particles that mold together and this is why it is called an oolite, also known as the egg stone. Stromatolites are mat colonies of algae bacteria that have a sticky surface that traps carbonate sediments. Both these and the oolites are great indicators of a shallow marine setting.

Geology of Iowa- Silurian

· Dolomite and carbonate mounds formed by five transgression/regression phases of the era define Iowa’s Silurian. Six dolomite formations make up the Silurian and are as follows from young to old: Gower, Scotch Grove, Hopkinton, Blanding, Tete des Morts, and finally Mosalem. These are also accompanied by two limestone formations: the La Porte City and Waucoma. Silurian outcroppings can be found all across east-central Iowa. Many of Iowa’s most famous state parks can be attributed to Iowa’s Silurian, more specifically the Hopkinton formation. Parks

like Maquoketa caves, Backbone, Palisades, and many more are made up of dolostone from the Hopkinton formation.

· Iowa's Silurian is also very economically valuable. This is most well represented by the Anamosa member of the Gower formation. This Anamosa member was mined in the 1840's and is still being mined today. Its constant bedding and uniform texture make it ideal to use in building and construction projects. Many other quarry projects are being carried out today across the eastern portion of the state targeted at Silurian bedrock. The Silurian limestone and dolostone are of use mostly in the aggregate industry, as gravel roads and cement.

Geology of Iowa- Devonian

· A marine environment for almost the entirety of the period dominated the Devonian in Iowa. This resulted in an abundance of deposition of limestone and dolostone but also some shale and siltstone in places. This makes the Devonian one of the most heavily mined ages of rock in Iowa. A band of outcroppings runs the length of the state north- south from the north central part of the state to the southeast, including much of Benton County. The formation the Devonian is most well known for would be the lithograph city formation. The limestone there is so pure and fine-grained that artists would use it for lithographic prints. The limestone found there also had and still has a major impact of the aggregate mining industry because the limestone is so well sorted.

In addition to limestone and dolostone, the Devonian contributes another resource to the economic value of its strata. A large number of evaporite deposits can be found in the Devonian, evaporite being largely associated with gypsum. This gypsum is distributed throughout the Devonian but a large amount can be found in the Coralville formation in the lower cedar valley group located mid-Devonian. Gypsum has many economic applications including cement and drywall.

Another interesting Devonian formation is the shell rock formation. This is the only Devonian formation to primarily be made up of fossiliferous carbonates. It also contains some

shale, but is mainly known for its fossiliferous limestone and dolostone. Suspended in these carbonates is anything from crinoids to brachiopods to bivalves. Stromatoporoids are also a very common sight in the shell rock formation.

Geology of Iowa- Carboniferous

Iowa's carboniferous saw the last of the marine environments in Iowa. Ten transgression/regression phases took place during the carboniferous resulting in multiple deposits of carbonate rock along with multiple unconformities. The carboniferous is split into two periods, the Mississippian and the Pennsylvanian. These two periods are divided by an unconformity consisting of about thirty years of lost time.

The Mississippian contains a very important aquifer that supplies water to many Iowans. Also within the Mississippian are two very interesting formations. The Burlington formation is made up mostly of a very uniform fine-grained chert. The Native Americans used this chert extensively in the form of arrowheads because it's fractures were so concise. This chert also served as an excellent preserving agent as numerous crinoids can be found within the Burlington formation. The other Mississippian formation of interest is the Warsaw formation. The lower Warsaw is composed mostly of argillaceous dolostone and shale and this resulted in an abundance of geodes, Iowa's state rock.

· The other period of the Carboniferous, the Pennsylvanian, consisted of mostly coastal swamps and shallow seas. Most of the Pennsylvanian is comprised of the Forest City basin. The Forest City basin dominates the outcropping bedrock in southwestern Iowa covering approximately a quarter of the entire state's bedrock. AS one could expect from swampy conditions, coal was deposited during the Pennsylvanian and exists to day as mostly bituminous and sub-bituminous coal. This coal is not ideal to burn because it contains many contaminants such as high sulfur content and high ash content.

Benton County- Bedrock

Benton County's bedrock is comprised predominantly of Devonian age rock with one major outcrop of Pennsylvanian and a very small outcrop of Silurian. The small Silurian outcrop is located at the southern tip of the cedar valley is part of the scotch grove formation, containing mostly dolomite and chert. Taking up about thirty square miles of territory, the Pennsylvanian outcrop includes mostly shale and sandstone, as does most of the lower Cherokee group. However the youngest age of bedrock is not the only period of Iowa's bedrock that we are concerned with.

As far as Benton County's Precambrian is concerned, most of the county is on top of the northeast Iowa plutonic complex. The northeast Iowa plutonic complex consists of very dense, iron rich rocks. Most commonly Fe_3O_4, or magnetite, which emits a magnetic anomaly which is very helpful in the process of mapping these minerals because they are so far underground (R. Anderson). Magnetite contains the highest concentration of iron out of any mineral (72.4%), making it the most commonly mined ore of iron. The reason this iron rich mineral below Benton County is not being utilized is because it exists so far underground. These igneous rocks are very common throughout Iowa's Precambrian and produce gravitational anomalies as well that aid in mapping the entirety of "Iowa's Basement".

As seen in figure 3, two Devonian age groups make up all of Benton county's bedrock: the lime creek formation and the cedar valley group. Although the cedar valley group is fairly large, Benton County contains many of the formations within the cedar valley group, including the shell rock and Coralville formations. These two formations contain mostly carbonate rock with some shale and evaporite deposits in places. This carbonate rock includes many fossils making fossiliferous limestone is not uncommon. Along the banks of the Cedar River, for example, one could not walk ten feet without seeing at least fragments of fossils. Both of these formations were deposited in very similar environments, a transgression/regression cycle. The Shell Rock formation was deposited in more of an open marine environment while the Coralville

displays a shallowing upward pattern suggesting its average depth was shallower than the Shell Rock.

The Lime Creek formation consists largely of shale, including calcareous shale, with some limestone as well. The lime creek formation is known for its great preservation and is home to an abundance of well-preserved fossils. These fossils include some large brachiopods and the colonial coral *Hexagtonaria.* These fossils have been collected in the BL Anderson Quarry in the northeast corner of the county. (UIowa, 2014)

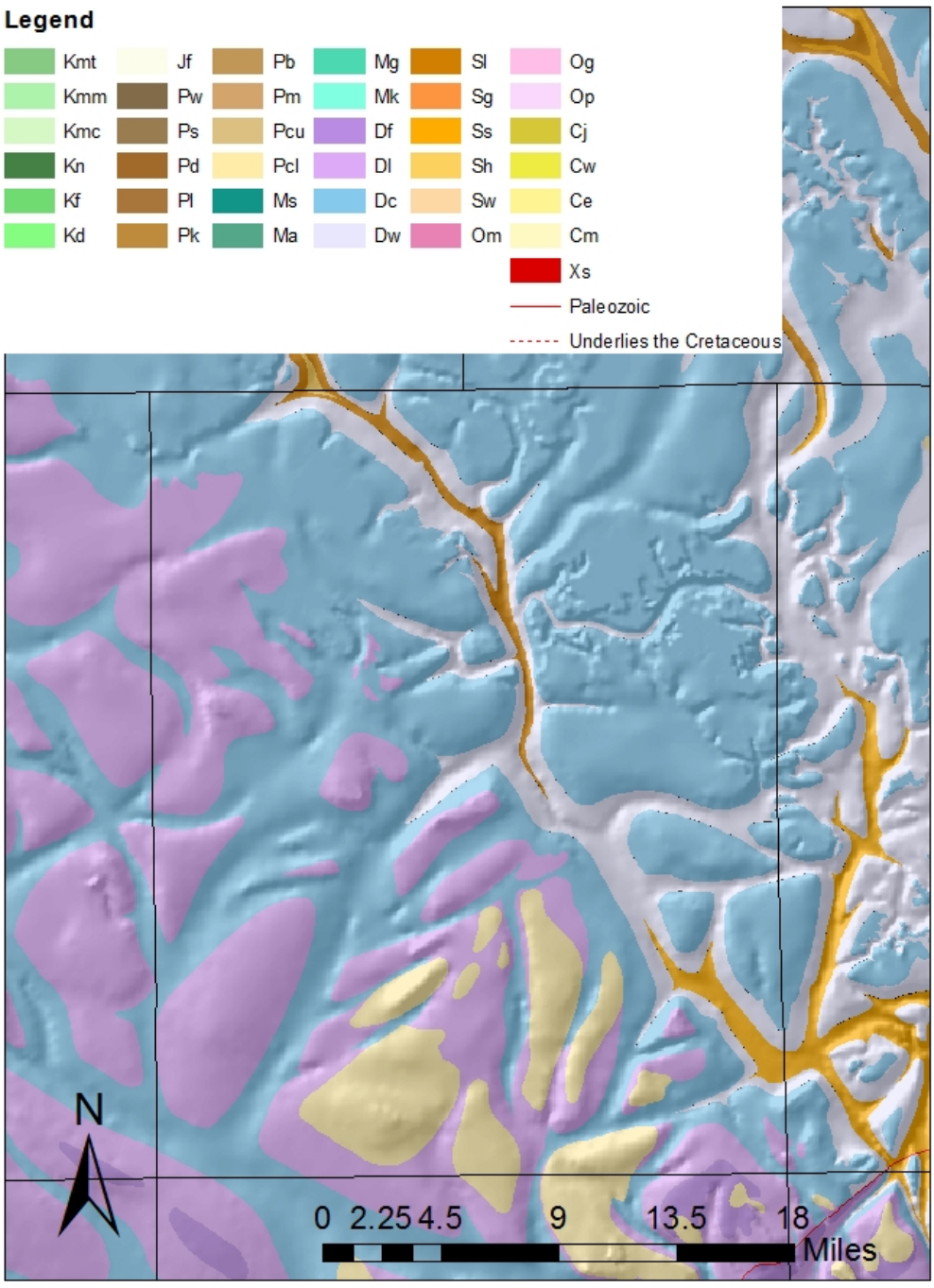
Bedrock Geology of Iowa
Legend
Kmt
Kmm
Kmc
Kn
Kf
Kd
Jf
Pw
Ps
Pd
Pl
Pk
Pb
Pm
Pcu
Pcl
Ms
Ma
Mg
Mk
Df
Dl
Dc
Dw
Sl
Sg
Ss
Sh
Sw
Om
Og
Op
Cj
Cw
Ce
Cm
Xs
Paleozoic
Underlies the Cretaceous
N
0 2.25 4.5 9 13.5 18
Miles

Figure 2

Benton County- Landform Regions

Benton County resides mostly on the Iowan surface landform region that extends from northeast Iowa to the mid-western border with Illinois, as illustrated in figure 5. This landform region is characterized by long, gently rolling slopes and low relief. This area was primarily formed by a period of heavy frost action, down slope movement of water-soaked soil materials, and strong winds around twenty thousand years ago (IowaDNR, 2015). Benton County has a very well developed watershed that is supported by the Cedar River. The Cedar River runs northwest to southeast through the county and its watershed covers over five million acres before finally draining into the Mississippi river (About the Watershed, 2015). As far as the landforms of the state as a whole are concerned, that can be seen in figure 4.

The most major flooding event in recent history would be the flood of 2008 and it devastated the entire Cedar River valley. This flood set a Cedar River record with a magnitude of over thirty feet. Almost twenty thousand people were affected by the flood in Cedar Rapids alone. This flood also had a major impact in Benton County, more specifically my hometown of Vinton. It seemed like the whole town was out sandbagging for days on end and at the peak, there were boats moored on the courthouse lawn, over five blocks from the river.

Landform Regions of Iowa

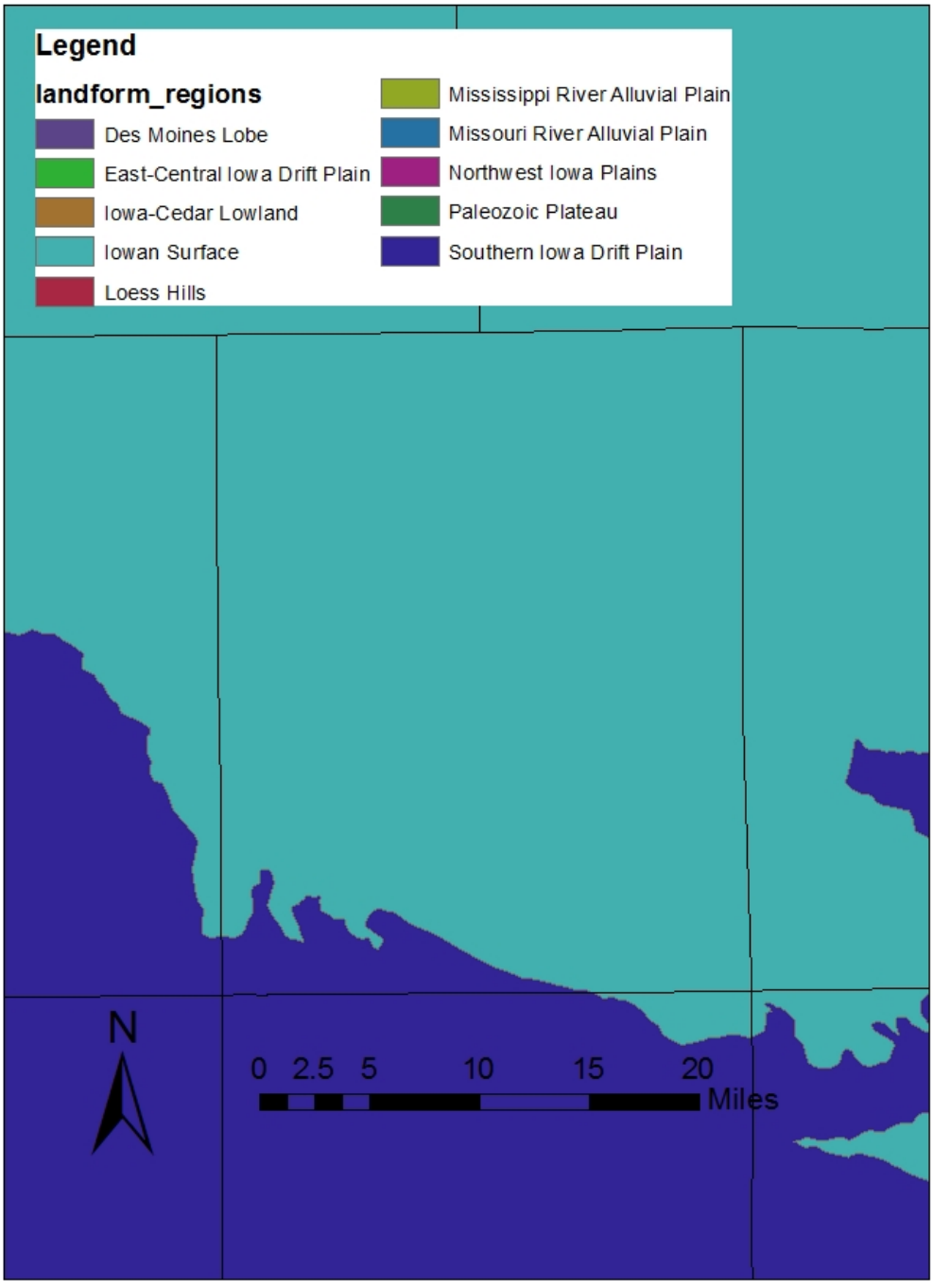

Figure 5

Landform Regions of Iowa

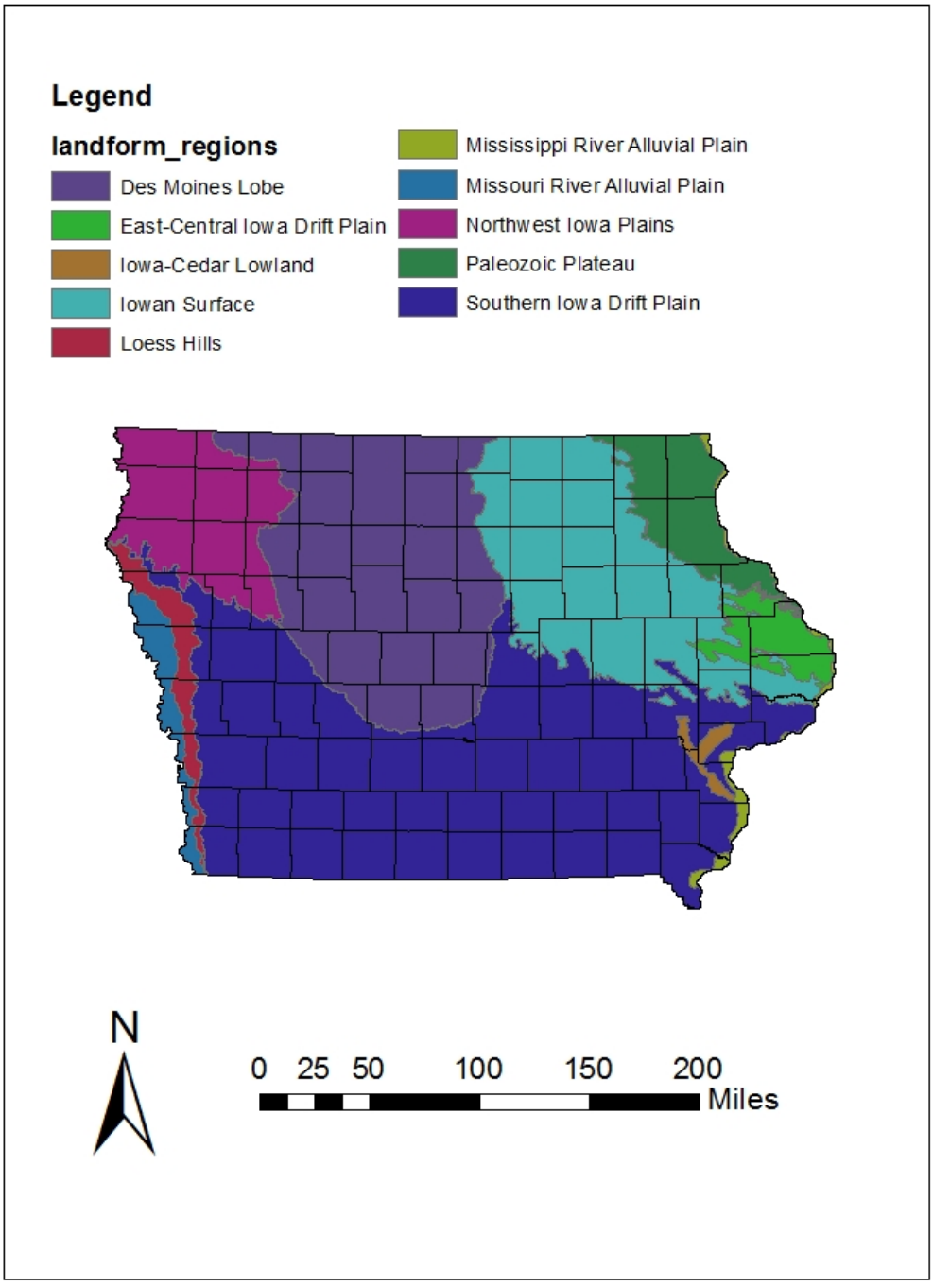

Figure 4

Benton County- Resources

There are three quarries found in Benton County alone and the resources found are a necessity for the modern world. The most common resource in Benton County and in the state no doubt is limestone. Many varieties of limestone can be purchased through the Benton county quarries including agricultural limestone, fill limestone, and of course, road limestone. Over 60% of Iowa's public road system is gravel, and this gravel has to come from somewhere (Nauman, 2014). Luckily most of it does not have to travel very far considering the abundance of limestone throughout the state. Other resources offered by Benton County include clay fill for building sites or grading jobs, concrete sand, mason sand for masonry work, and river gravel for landscaping or septic beds. There is one more resource that not only Benton county but the whole state of Iowa is known for: Black dirt. This, unlike other resources, is for the most part, not transported. It is utilized as it is in agriculture.

Agriculture is by far Iowa's biggest industry. One out of every three dollars spent in Iowa are agriculture related and is responsible for over four hundred thousand jobs, approximately a fifth of the total jobs in Iowa. Crop farming alone contributed around fifty billion dollars to Iowa's economy in 2012; double what the figure was just five years ago (Iowa Ag Economic Contribution Study, 2014). As astounding as these numbers are, none of it would be possible if not for the rich, fertile soil of our state. The soil of benton county in particular is no less fertile than the rest of the state. As you can see in figure 6, the soil in and around Vinton is primarily the tama series. The tama series is a fine-silty, mixed, superactive, mesic typic argiudolls. The a-horizon is typically twenty-five to fifty centimeters thick, made up of very dark brown silty clay loam.This soil remains a very friable silty clay loam up to 150 centimeters deep, making it the perfect soil for crop production.

Soil Series of the Vinton Area

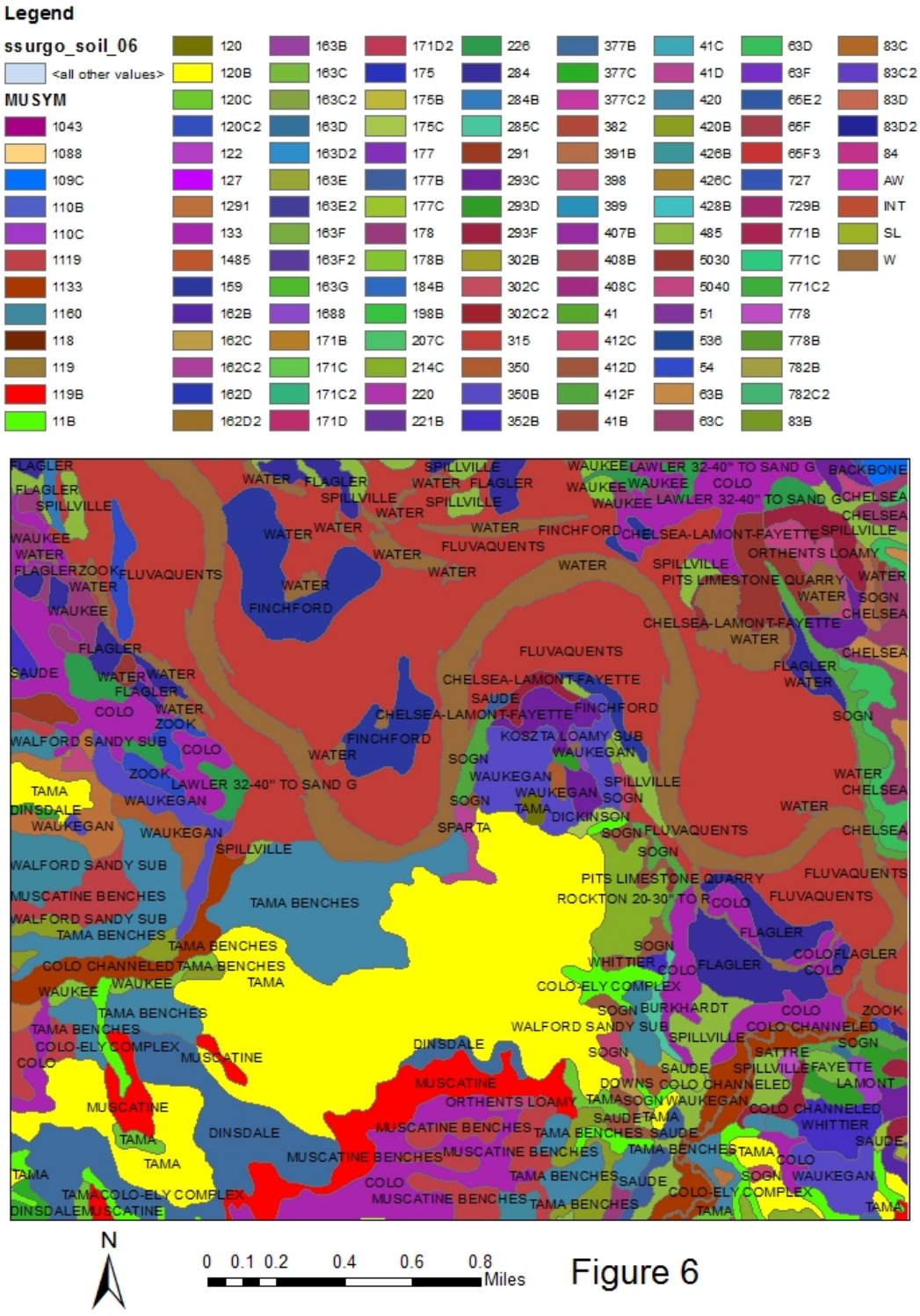

Figure 6

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