








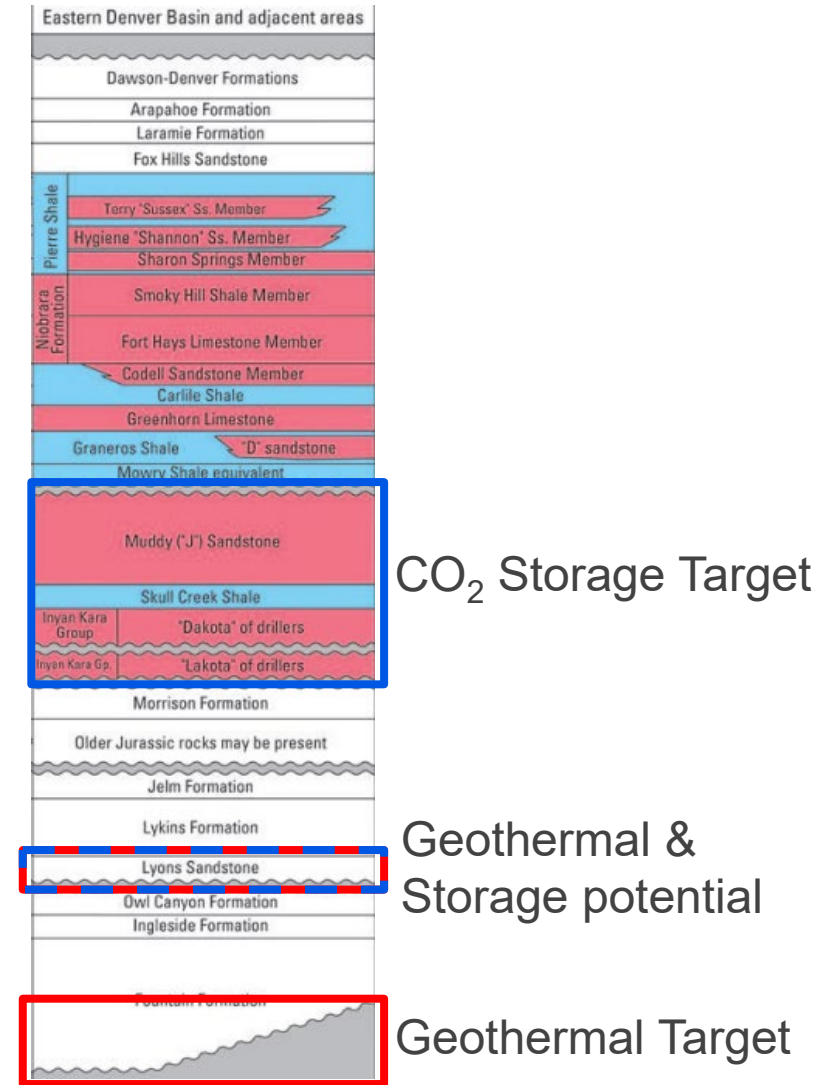
Example Play Fairways: Geothermally-powered Direct Air Capture + Storage

PM: Amy Lang
PI: Aubrey Collie

Map symbol explanation

-  Low Risk Geothermal Fairway
-  Moderate Risk Geothermal Fairway
-  High Risk Geothermal Fairway
-  CO₂ Storage Fairway with storage formation names
-  Example GDAC Facility
-  Example CO₂ Storage Facility
-  Example CO₂ pipeline

Example Stratigraphic Column



Texas Gulf Coast Sedimentary Geothermal Fairway

Geothermal Targets:

Sedimentary: Frio, Wilcox, Smackover, Norphlet, and other formations.

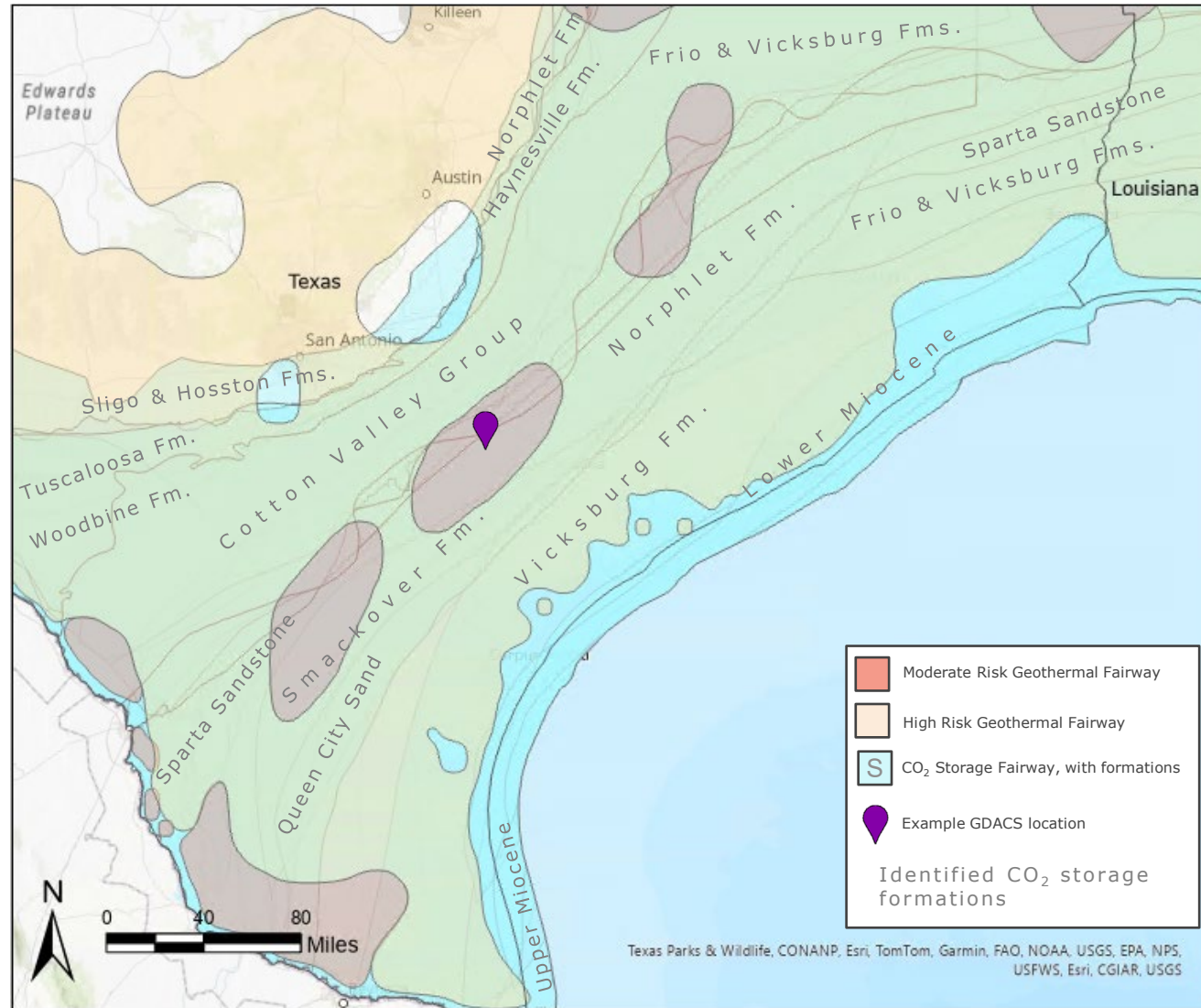
Geothermal gradient: 30-60°C/km

Target Depth: >km

A key element of gulf coast sedimentary geothermal plays are areas of significant overpressure, enhancing fluid flow and delivery of heat to power generation facilities.

Storage Targets:

There are at least a dozen potential carbon storage formations and at least that many storage fairways along the Texas Gulf Coast, with billions of tonnes of storage targeted for appraisal and derisking over the next decade. (Roberts-Ashby et al, 2014)



PERIOD	EPOCH	AGE	GROUP OR FORMATION
QUAT.	PLISTOCENE	Calabrian	Undifferentiated
	HOLOCENE		
NEOGENE	PLIOCENE	Piacenzian	Undifferentiated
	MIOCENE	Messinian Tortonian Sarmatian Langhian Burdigalian Aputanian	Fleming Fm.
	EGGONE	Chattian	Anahuac Fm. Frio Fm.
PALEOGENE	Eocene	Rupelian	Vicksburg
		Priabonian Bartonian	Jackson Claiborne Gp.
	Oligocene	Ypresian	Wilcox
			Midway Gp.
UPPER CRETACEOUS	Maastrichtian	Navarro (Olmec Fm. / Escudido Fm.)	
		Taylor Gp. (Anacacho Ls. / San Miguel Fm. / Ozan Fm. / Annona Chalk)	
	Albian	Santonian	Austin Gp. / Tokio Fm. / Eutaw Fm.
		Coniacian	
LOWER CRETACEOUS	Turonian	Eagle Ford Woodbine / Tuscaloosa Washita Gp. (Bulla Limestone) Fredericksburg Gp. (Edwards Ls. / Paluxy) Glen Rose (Rodessa Fm.)	
		Cenomanian	
	Albian	Pearsall Fm. – James Ls.	
UPPER JURASSIC	Tithonian	Sligo Fm.	
		Barremian Hauterivian	Hosston Fm. (Travis Peak Fm.)
	Kimmeridgian	Valanginian Barrerasian	Cotton Valley Bossier Fm.
		Oxfordian	Haynesville Fm. / Glen Rose Ls. Smackover Fm. Norphlet Fm.
UPPER JURASSIC	L. MID	Callonian	Louann Salt Werner Fm.
		Bathonian	
UPPER TRIASSIC	UP	Hettangian	
		Rhaetian Norian Carinan	Eagle Mills Fm.

Generalized Texas Gulf Coast stratigraphy, from Wisian et al, 2023

Washington & Oregon Basalt Storage

Geothermal Target:

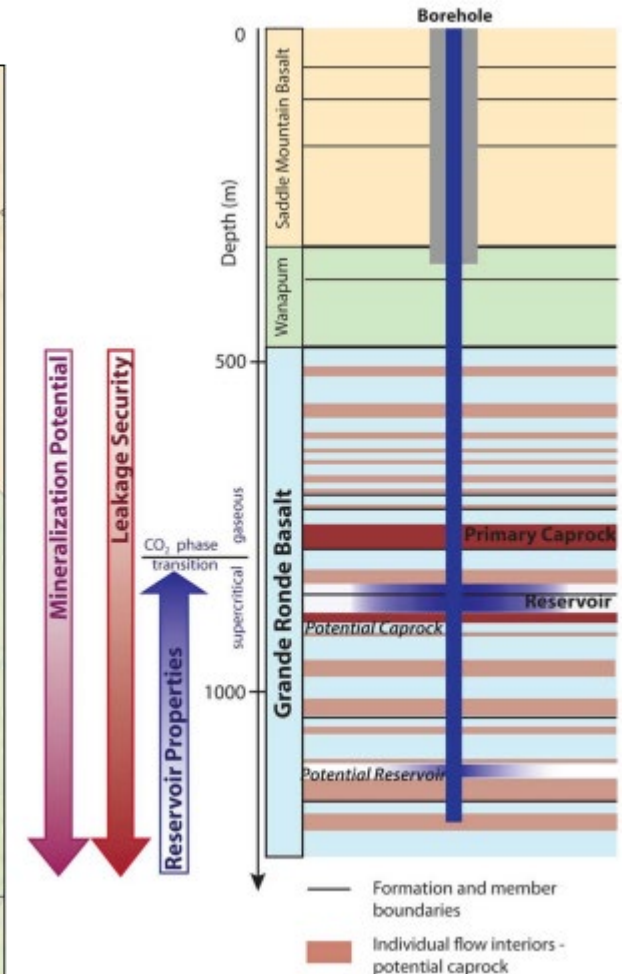
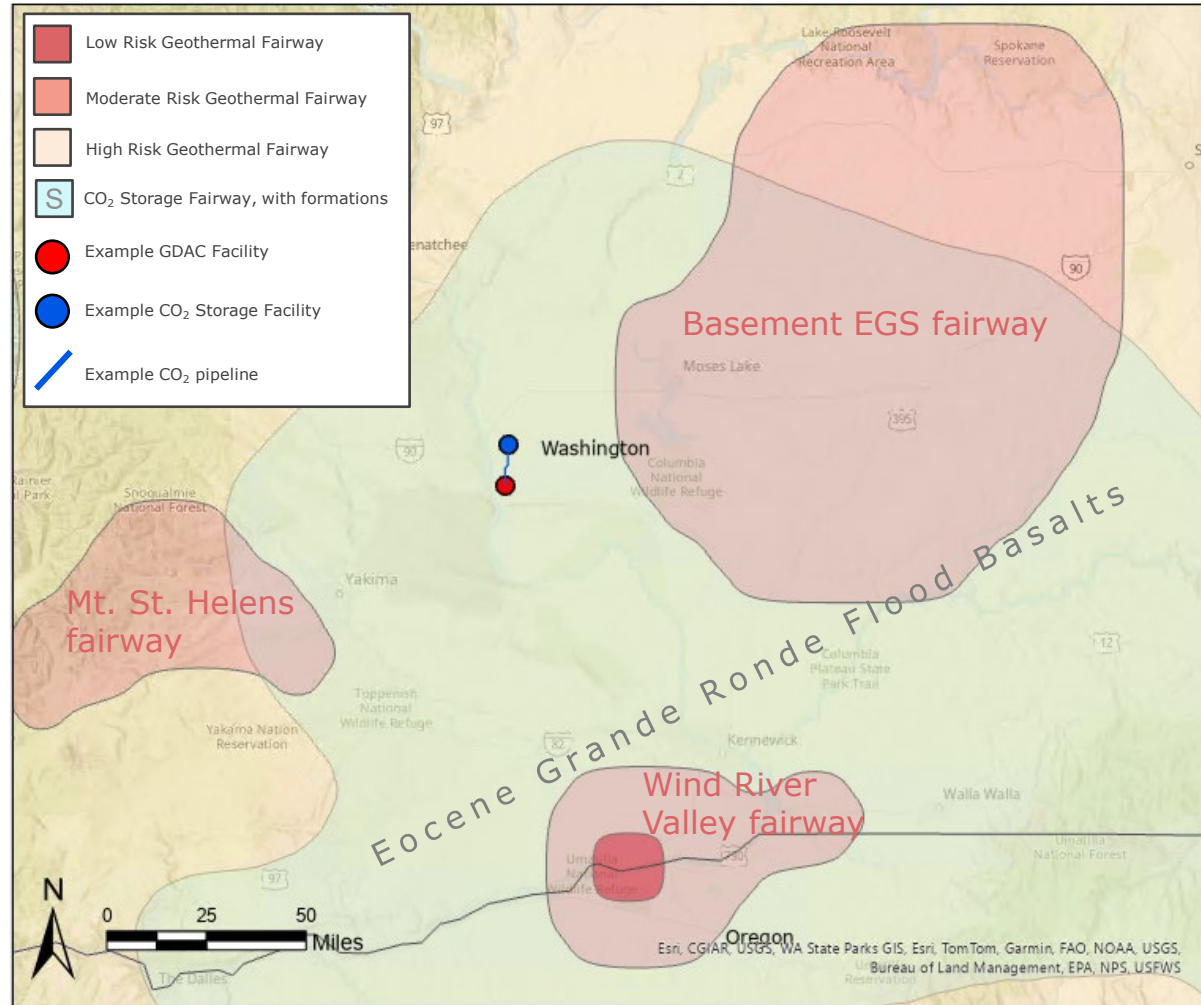
Basement EGS with potential for hydrothermal systems in the Mt. St. Helens and Wind River Valley areas (Forson et al, 2015).

Geothermal gradient: 30-35°C/km (GeoMap)

Target Depth: 5-7 km

Storage Target:

Porous flood basalts within the Grande Ronde formation may be able to store hundreds of gigatons of CO₂ via both mineralization and conventional structural and capillary trapping. (Cao et al, 2023; McGrail, 2011)



Generalized Columbia River Basalt Group stratigraphy at the Wallula test site, from Zakharova et al, 2012.

West Virginia

Geothermal Target:

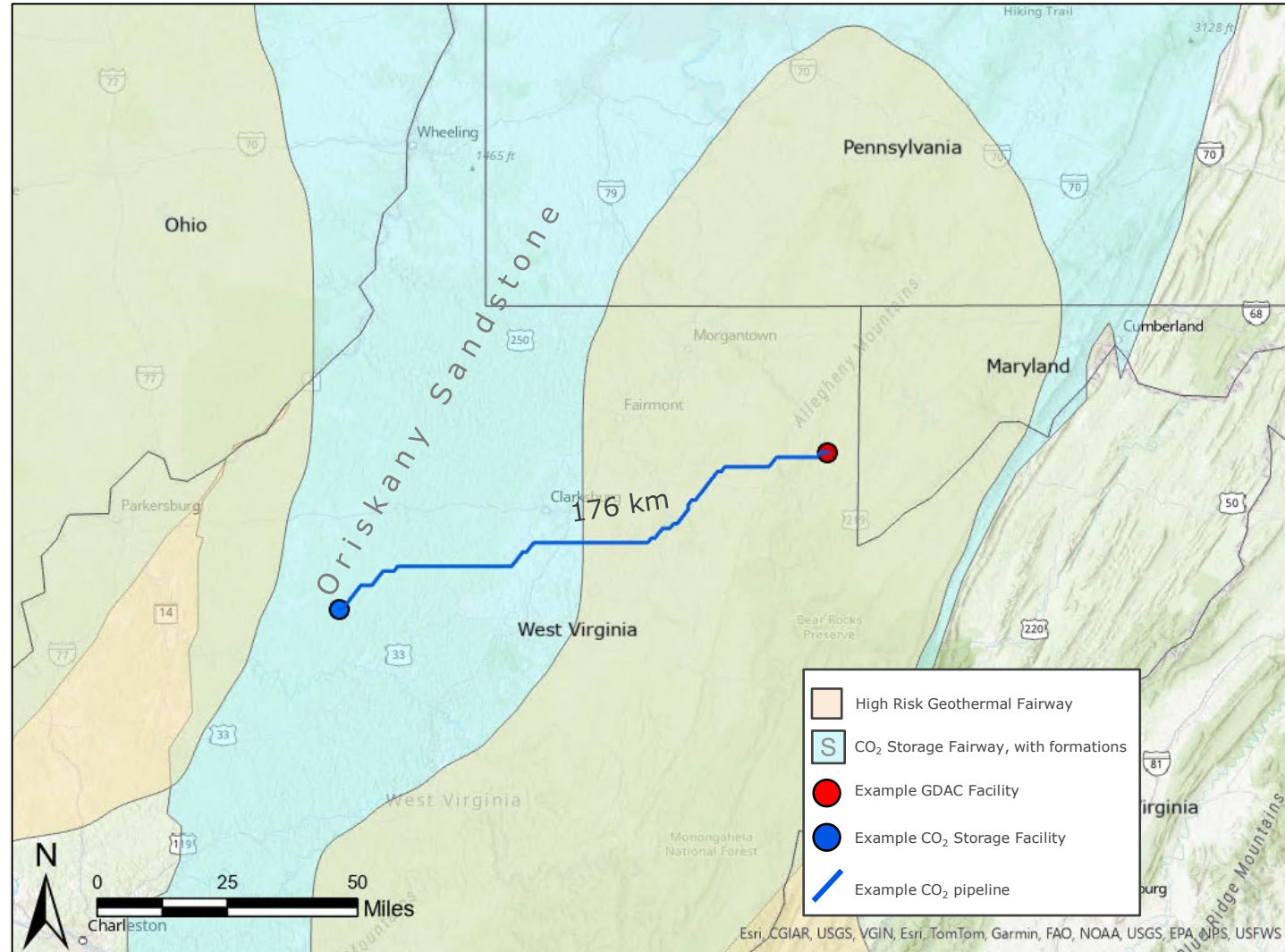
EGS: Basement
Sedimentary: Tuscarora Sandstone

Geothermal gradient: 26-31°C/km (GeoMap; West Virginia Geological and Economic Survey)

Target Depth: 6.5-7.5km

Storage Target:

Primary storage target is the Devonian Oriskany Sandstone, which has exceptional injectivity and storage capacity. (MRCI, 2024)



General West Virginia Stratigraphy		
System / Age	Lithology	Formation Names
PENNSYLVANIAN 290-323 m. y.		Monongahela Group
		Conemaugh Group
		Allegheny Group
MISSISSIPPIAN 323-354 m. y.		Pottsville
		Mauch Chunk Group
		Greenbrier
		Maccrady Pocono Group
DEVONIAN 354-417 m. y.		Devonian Shales/Siltstones
		Brallier
		Tully
		Marcellus
		Oriskany
STURDIAN 417-443 m. y.		Keiser
		McKenzie
		Rose Hill
		Tuscarora
ORDOVICIAN 443-490 m. y.		Trenton
		Utica/Martinsburg
		Black River
		Chazy
		Knox Beekmantown Copper Ridge
CAMBRIAN 490-570 m. y.		Conasauga
		Rome
		Tomstown
		Mt. Simon
		Pre-Cambrian Basement

Idaho Falls, Idaho

Geothermal Target:

Basement and volcanic enhanced geothermal targets associated with relict hotspot activity within the Snake River Plain, as well as potential for shallower blind systems in the Idaho thrust belt. (Jones et al, 2021)

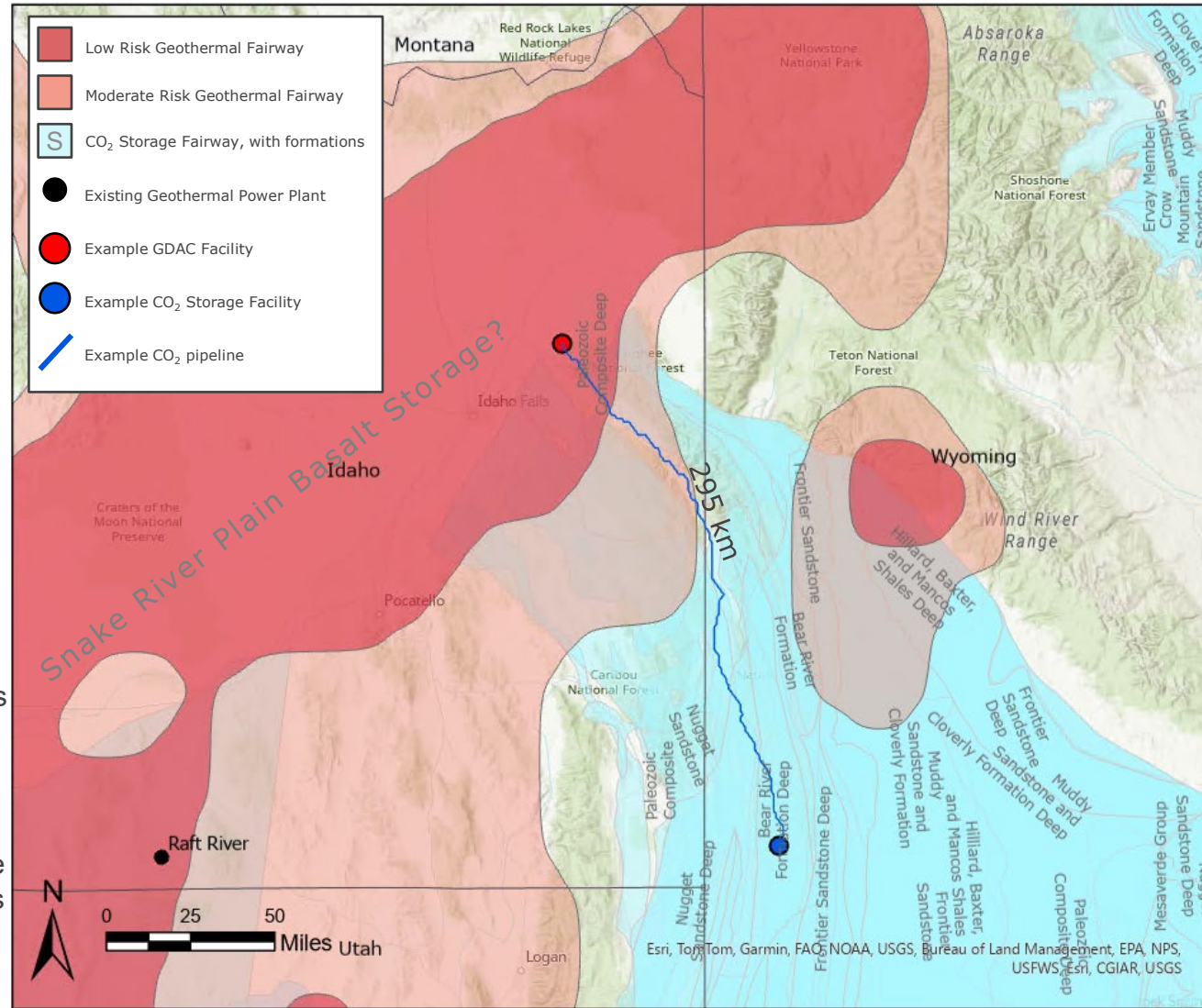
Geothermal gradient:
41-90°C/km (GeoMap; WVGES)

Target Depth: 2.5-6 km

Storage Target:

Multiple saline storage targets exist within the Wyoming-Utah thrust belt region, including high quality targets within the Nugget Sandstone and Frontier Formation. There are also numerous depleted hydrocarbon fields that may also be suitable storage targets. (Buursink et al, 2012)

There may also be suitable storage targets within the basalts of the Snake River Plain, although these formations are not as well developed as similar formations in the Columbia River basalts. (Pollyea & Fairley, 2012)



Era	System / Series	Stratigraphic unit	
Cenozoic	Tertiary	Green River Formation	
		Wasatch Formation	
		Evanston Formation	
		Adaville Formation	
		Hilliard Shale	
Cretaceous	Upper	Frontier Formation	
		Aspen, Shell Creek, and Mowry Shales	
		Bear River Formation	
Mesozoic	Lower	Gannett Group	
		Stump Formation	
	Jurassic	?	Preuss Sandstone
			Gypsum Spring Member
			Twin Creek Limestone
	Triassic	Chugwater Group	Nugget Sandstone
			Ankareh Formation
			Thaynes Formation
			Woodside Formation
			Dinwoody Formation
Permian		Phosphoria and Park City Formations	
Pennsylvanian		Wells Formation	
		Tensleep Sandstone	
Mississippian		Amsden Formation	
		Madison Limestone	
		Mission Canyon Limestone	
Devonian		Lodgepole Limestone	
		Darby Formation	
Ordovician		Three Forks Formation	
		Jefferson Formation	
Cambrian		Bighorn Dolomite	
		Gallatin Formation	
		Gros Ventre Formation	
		Flathead Sandstone	

Vallez Caldera, Rio Grande Rift, New Mexico

Geothermal Target:

Valles Caldera geothermal system

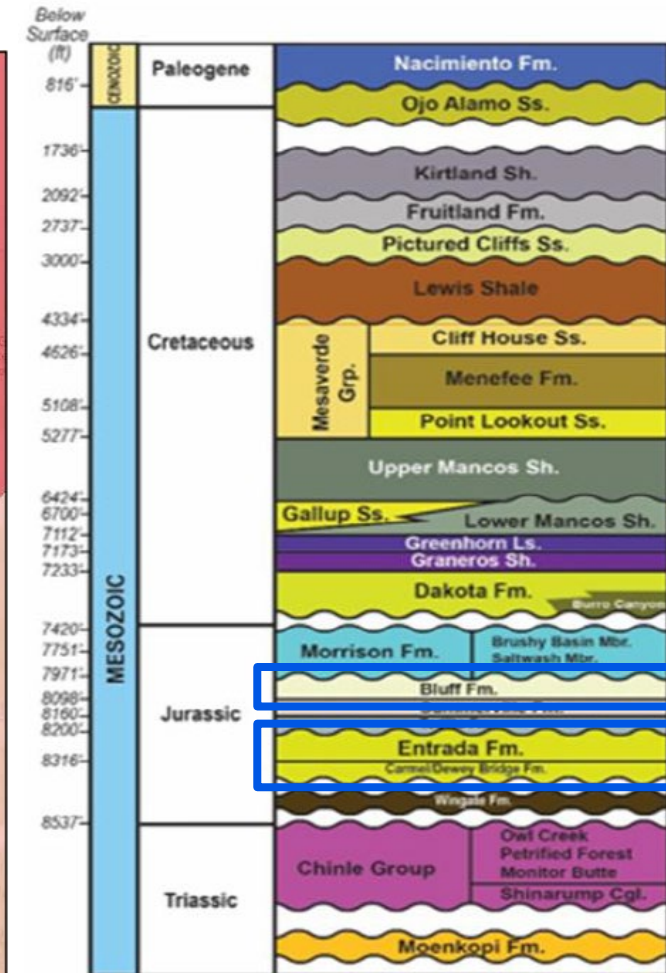
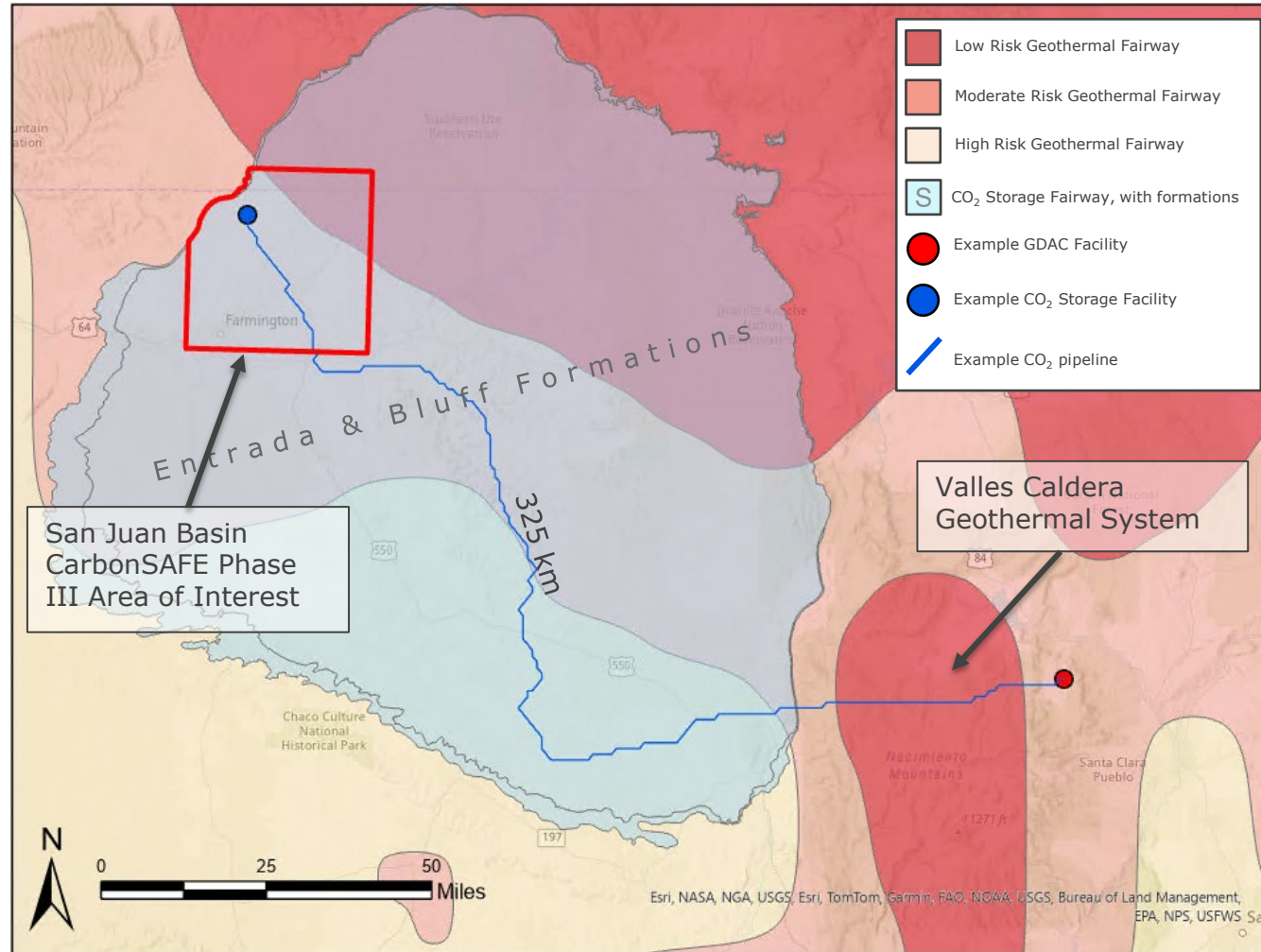
Geothermal gradient:

50-60°C/km (Goff & Grigsby, 1982)

Target Depth: 3-5km

Storage Target:

Storage is available in both the Entrada and Bluff Formations. Both formations are likely able to accept hundreds of gigatons of storage each, with high-quality targets existing primarily within the northwestern portion of the San Juan Basin and potential secondary targets elsewhere in the basin (Sarkodie-Kyeremeh et al, 2022).



Carbon storage stratigraphic column, Sarkodie-Kyeremeh et al, 2022. Target formation for the San Juan Basin CarbonSAFE project is the Entrada Formation, with secondary storage potential in the Bluff Formation.

Central Utah, FORGE analogue

Geothermal Target:

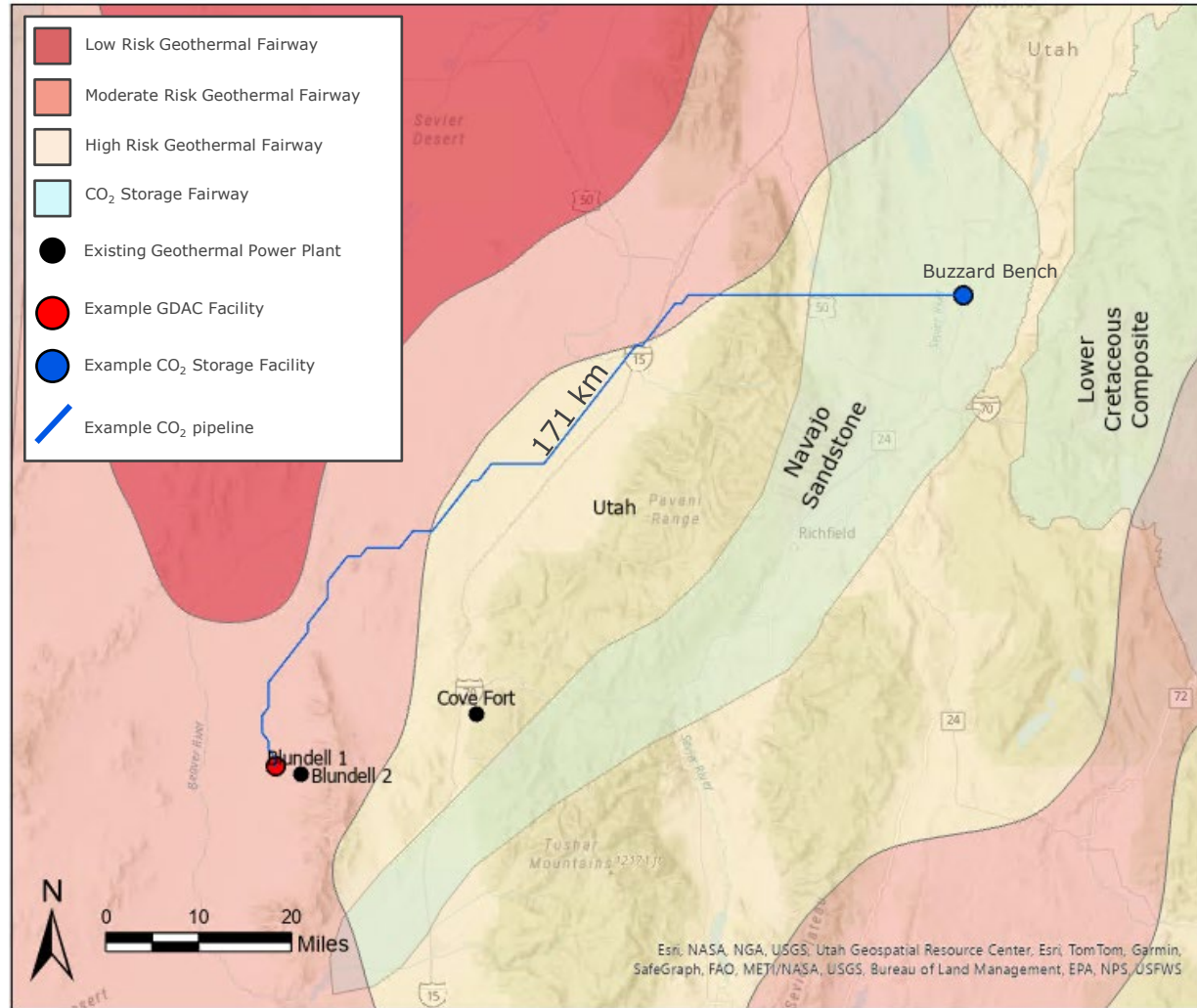
EGS: Plutonic basement targets
(Fervo, personal comms.)

Geothermal gradient:
35°C/km (GeoMap)
86°C/km @ FORGE site

Target Depth: 2-6km

Storage Targets:

Thick, clean sands in the Navajo Formation are likely able to accommodate at least 50 million tonnes of CO₂ (Xiao et al 2019). Secondary storage is available in the Kayenta and Wingate formations, and other plays may be available in Cretaceous formations and intermontane basin-filling sediments elsewhere in the state. (Buursink et al, 2014)



Period	Formation / Member	Thickness (m)	Lith.
CRET	Mancos Shale	Blue Gate Sh Mbr	100-400
		Ferron Ss Mbr	3-30
		Tununk Sh Mbr	105-125
	Dakota Sandstone	45	
	Cedar Mtn Fm	Upper member	30-60
	Buckhorn Cg Mbr	70	
JURASSIC	Morrison Formation	150	
	Summerville Formation	20	
	Curtis Formation	335	
	Entrada Formation	330	
	Carmel Formation	65-230	
	Navajo Sandstone	130-155	
	Kayenta Formation	58-110	
	Wingate Sandstone	80-120	
TRIASSIC	Chinle Formation	15	
	Moenkopi Fm	Upper member	120
		Sinbad Ls Mbr	50
		Black Dragon Mbr	100
PERM	Black Box Dolomite	100	
	White Rim Sandstone	100	
P	"Heramosa" Formation	150	
MISS	Madison Limestone	400	

Stratigraphic column for central Utah, modified from Xiao et al, 2019.

Dickinson, ND

Geothermal Target:

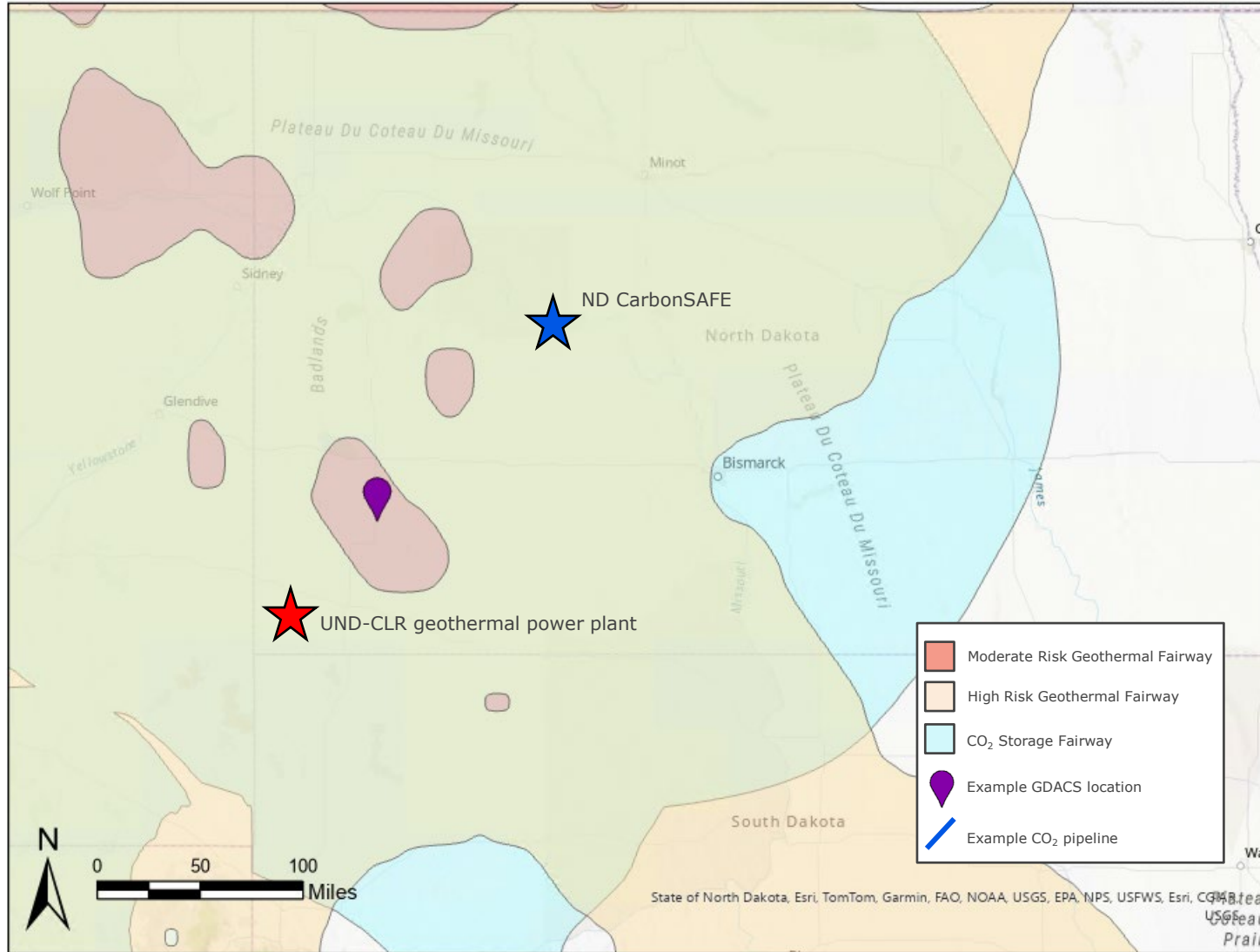
EGS: Basement
Sedimentary: Lodgepole, Deadwood, and other deep, high-permeability sands.

Geothermal gradient: 38°C/km (GeoMap)

Target Depth: 2.5-6km

Storage Targets:

The Williston basin contains multiple storage targets, including the Deadwood, Black Islands, Lower Swift, Inyan Kara, and Broom Creek formations. The North Dakota CarbonSAFE Phase III project has evaluated the Broom Creek formation and found it to be an excellent storage target. (Buursink et al, 2014)



ERA	SYSTEM	FORMATION OR GROUP	
MESOZOIC	TERTIARY	Fort Union Group	
	CRETACEOUS	Upper	Montana Group
			Colorado Group
	Lower	Inyan Kara Group	Dakota Group
		Morrison Formation	
	JURASSIC		Swift Formation
			Herdon Formation
			Piper Formation
	TRIASSIC		Nesson Formation
			Spearfish Formation
PERMIAN		Minnekahta Limestone	
		Opeche Formation	
		Minnelusa Formation	
	PENNSYLVANIAN	Amsden Group	
PALEOZOIC		Tyler Formation	
	Big Snowy Group	Heath Formation	
			Otter Formation
			Kibbey Formation
	MISSISSIPPIAN		Charles Formation
		Madison Group	Mission Canyon Limestone
			Lodgepole Limestone
	DEVONIAN		Bakken Formation
			Three Forks Formation
			Birdbear Formation
		Duperow Formation	
		Souris River Formation	
		Dawson Bay Formation	
SILURIAN		Prairie Formation	
		Winnipegosis Formation	
ORDOVICIAN		Interlake Formation	
		Stony Mountain Formation	
		Red River Formation	
CAMBRIAN		Winnipeg Formation	
		Deadwood Formation	
RECAMBRIAN		Pre-Beltian	

Modified from USGS

The Geysers Geothermal Area, California

Geothermal Target:

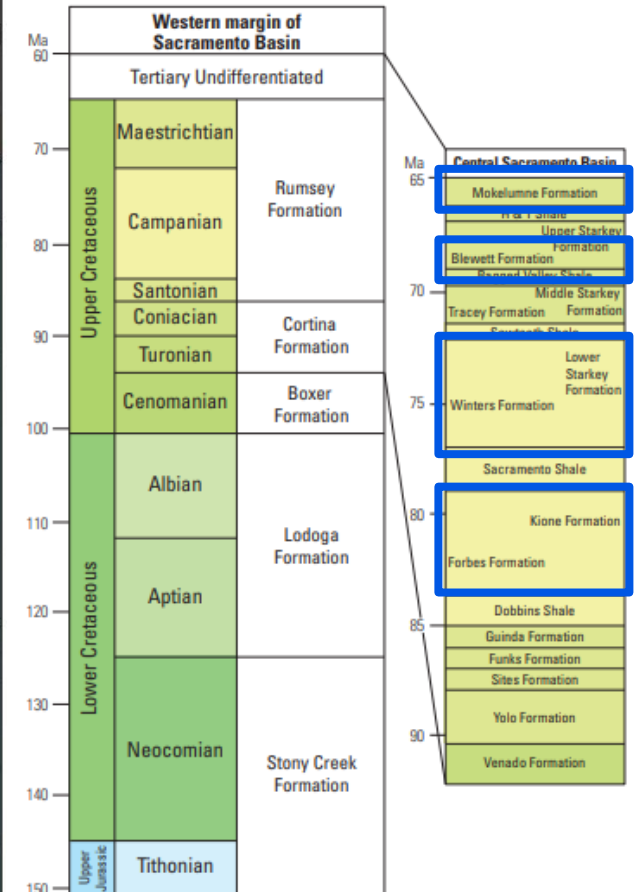
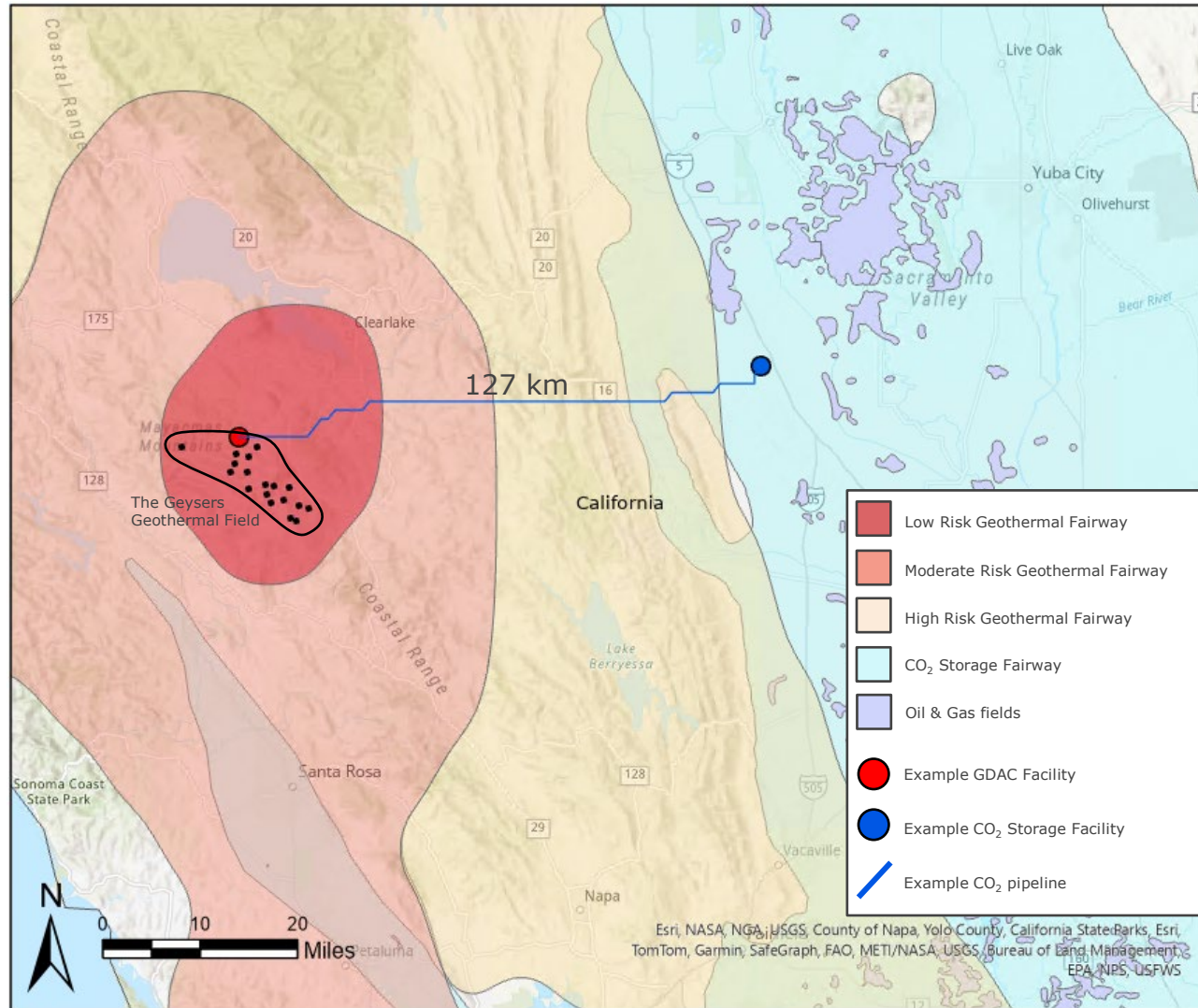
Shallow hydrothermal targets, shallow to medium-depth hot dry rock.

Geothermal gradient: Up to 130°C/km (Peacock et al., 2020)

Target Depth: 2-5km

Storage Targets:

Storage targets in the Sacramento basin include existing or depleted gas fields in the Kione, Mokelumne, and other formations, as well as saline aquifer targets in the Tracey, Blewett, and Starkey formations and various sands within the Great Valley Sequence. (Downey and Clinkenbeard, 2005; Oldenburg et al, 2017)



Sacramento Basin stratigraphic column with potential carbon storage targets identified in blue. (Modified from Schenk et al, 2019)

Longmont, Colorado (DJ Basin)

Geothermal Target: Greater Wattenberg Field Area (GWA)
 EGS/AGS: Basement
 Sedimentary: Lyons Sandstone

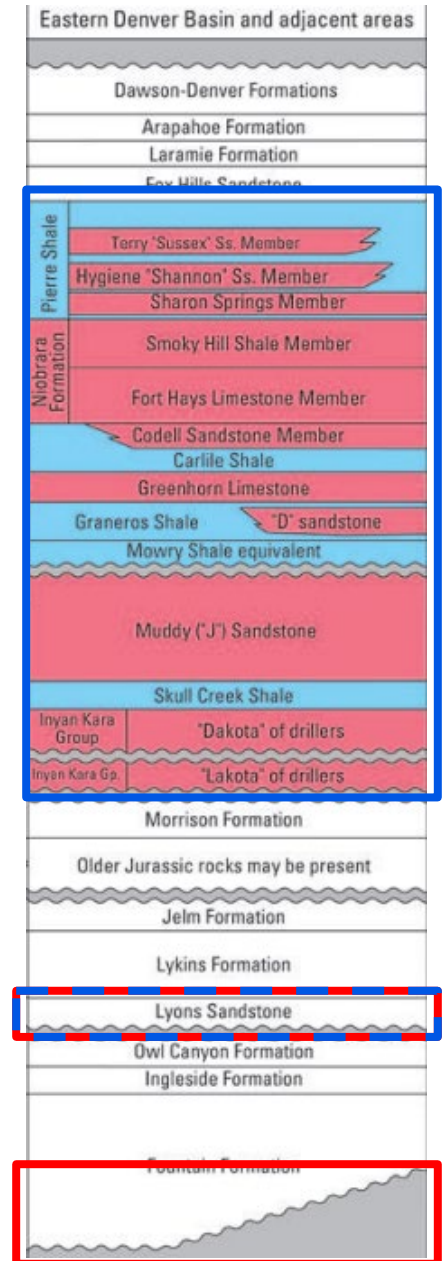
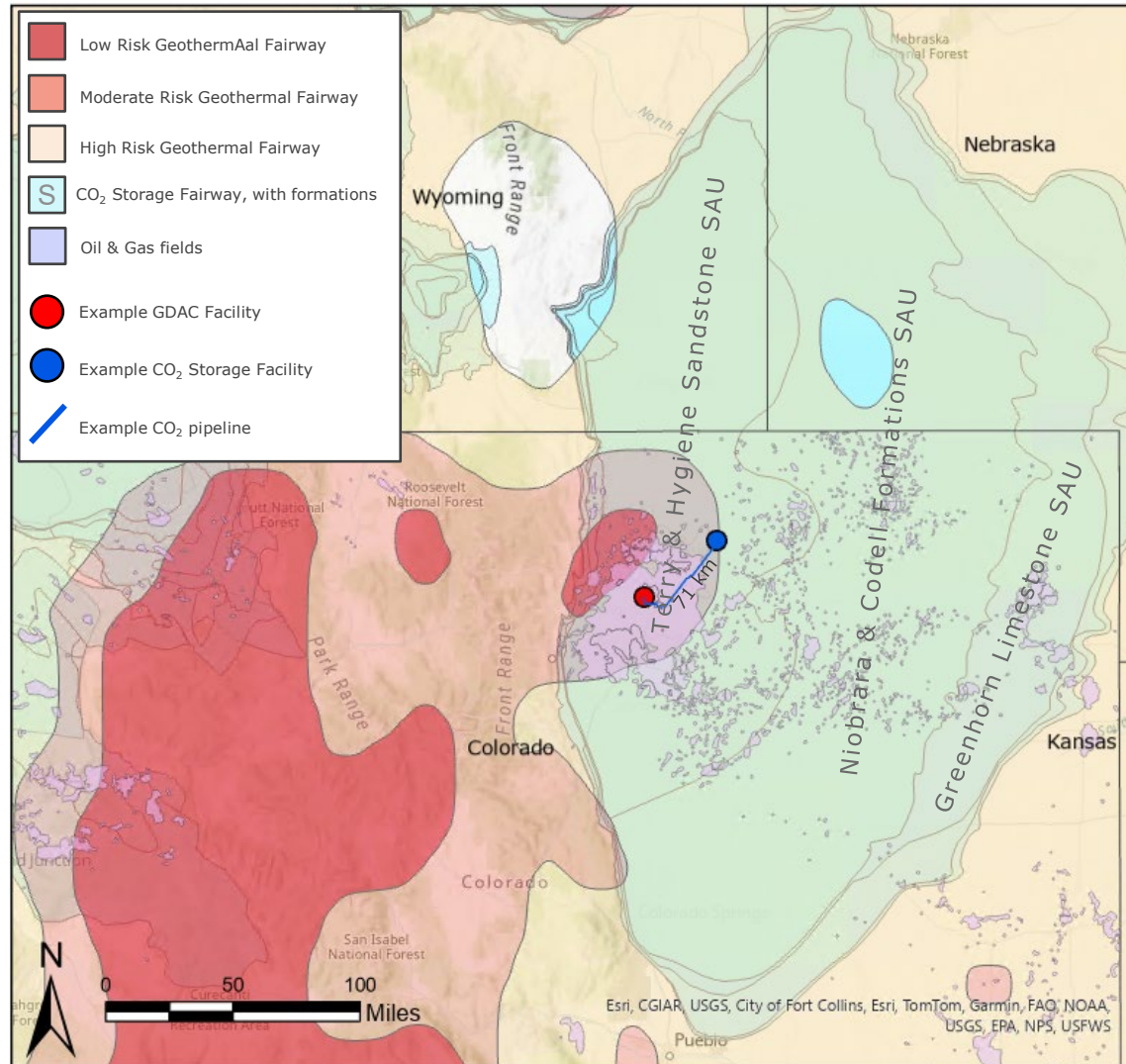
Geothermal gradient:
 30-47+°C/km (GeoMap; Lacazette et al, 2024)

Target Depth: 3-5 km

Geothermal appraisal activities are ongoing in the GWA, with tests planned for both sedimentary targets in the Lyons Formation (Geothermal Technologies, Inc) and basement target (Oxy's GLADE project).

Storage Targets:

- Various members of the Pierre Shale.
- Codell Sandstone
- Greenhorn Limestone
- Muddy Sandstone
- Lyons Sandstone



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