Evaluating the Impact of Saline Paleowater on Groundwater Quality in Coastal Deltas Using Morphodynamic and Hydrogeologic Modeling

Groundwater Resources Research Group

SFU

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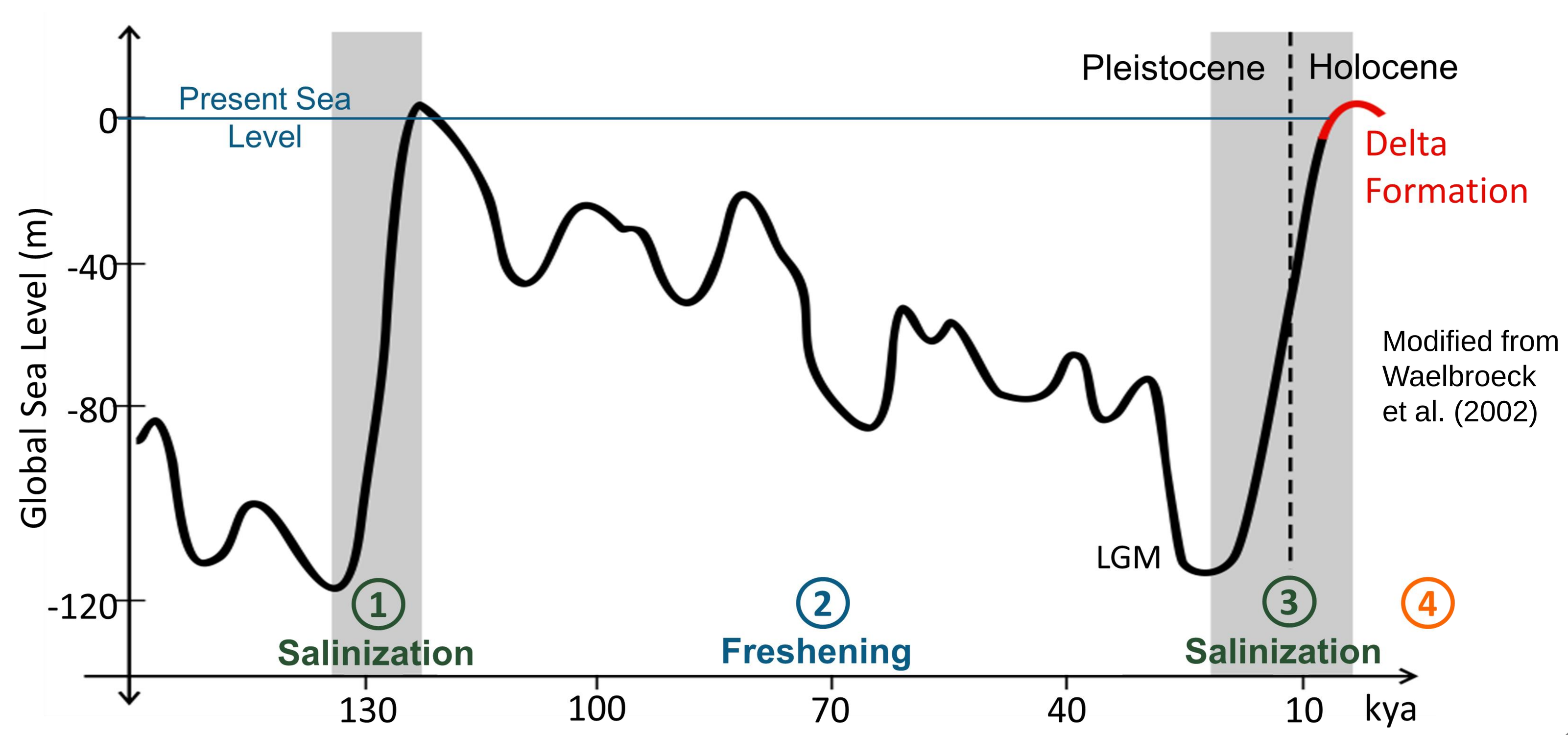
Highlights

1. The salinity distribution in coastal deltas is influenced by delta morphology and sea level history.
2. Deltas with varying degrees of wave and fluvial influence are created using morphodynamic modeling.
3. Output from morphodynamic modeling will be used as the geologic input into hydrogeologic models to determine how delta morphology impacts groundwater salinity it coastal deltas.

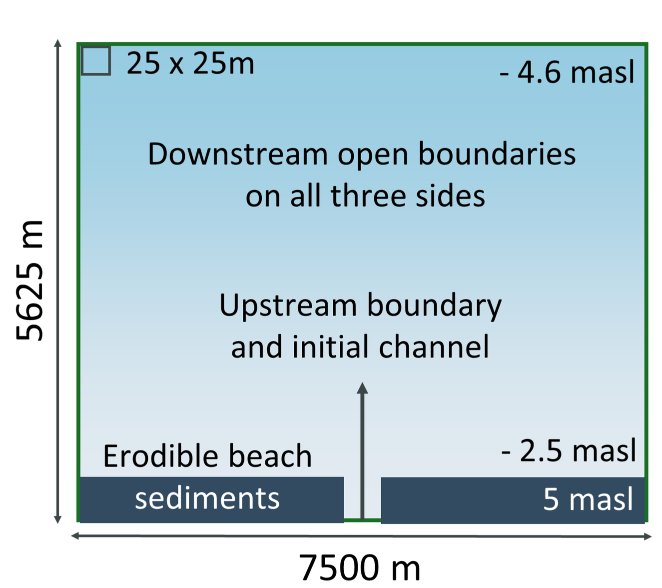
Background

1. During marine transgressions, dense saline water infiltrates into underlying aquifers, replacing and expelling fresh groundwater. Marine sediments deposited at the surface form aquitards with saline porewater.
2. During marine regressions, freshwater recharges the system and flushes salinity from the aquifers. This freshening process occurs at a much slower rate than salinization and may be inhibited by existing aquitards.
3. Since the last glacial maximum (LGM), coastal aquifers have experienced salinization. Holocene deltas began forming 6-8K years ago when sediment accumulation began to outpace sea level rise (Stanley and Warne, 1994).
4. The current availability of freshwater in coastal deltas depends on the heterogeneity of the fluvial sediments and marine aquitards



Morphodynamic Modeling

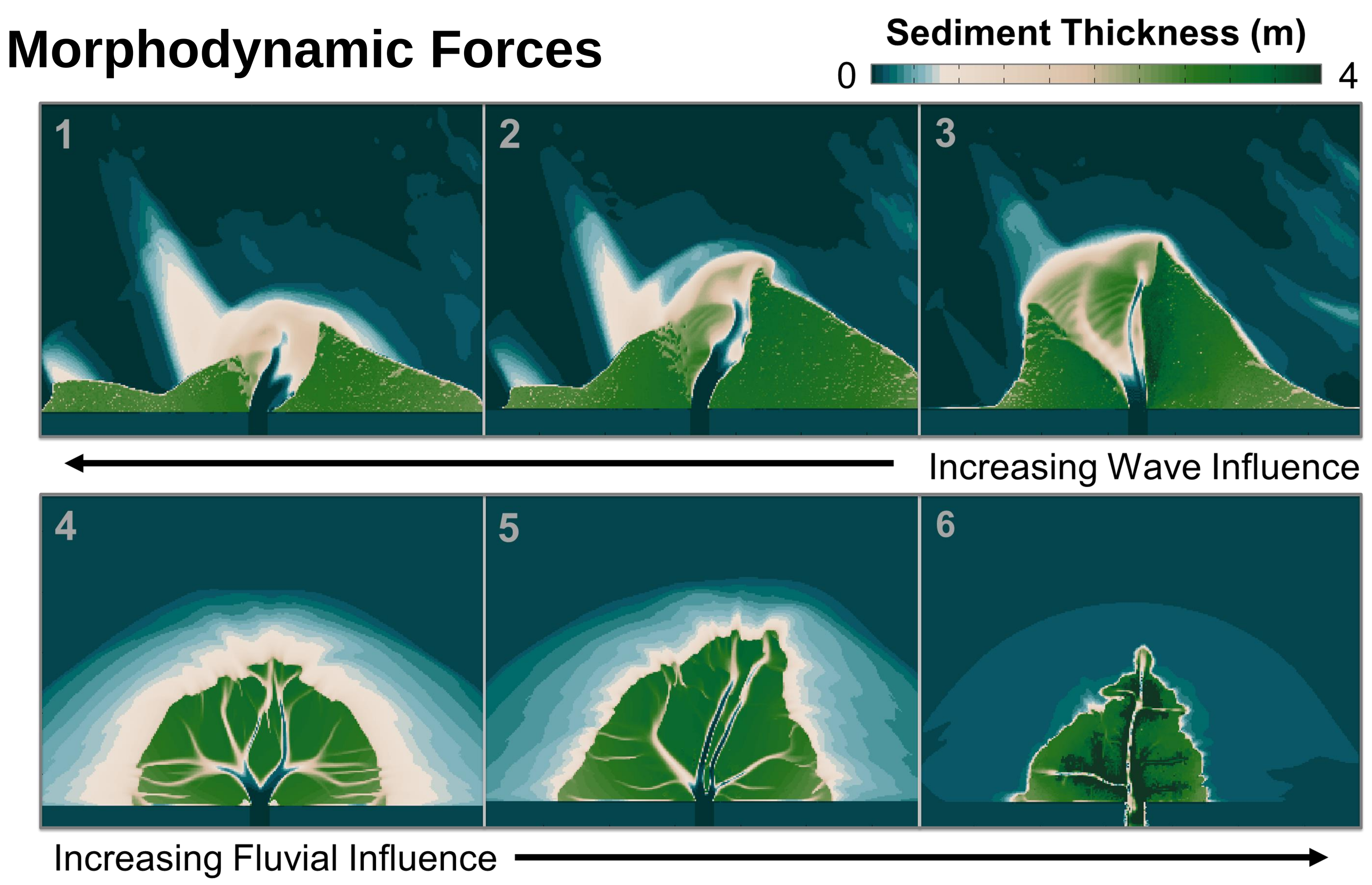
- Delft3D-FLOW is used to model the formation of coastal deltas throughout the Holocene.
- The model domain is based on Caldwell & Edmonds (2012).



Simulation Set-up and Boundary Conditions	Value
Initial channel dimensions (width x depth)	250 x 2.5 m
Downstream Boundary: Constant water surface elevation	0 m
Downstream Boundary: Constant water salinity	35 ppt
Downstream Boundary: Total sediment concentration	0 $kg\ m^{-3}$
Upstream Open Boundary: Incoming water salinity	0 ppt
Upstream Open Boundary: Median Sediment Diameter φ_{50}	5
Upstream Open Boundary: Sediment Flux	0.0377 $m^3\ s^{-1}$

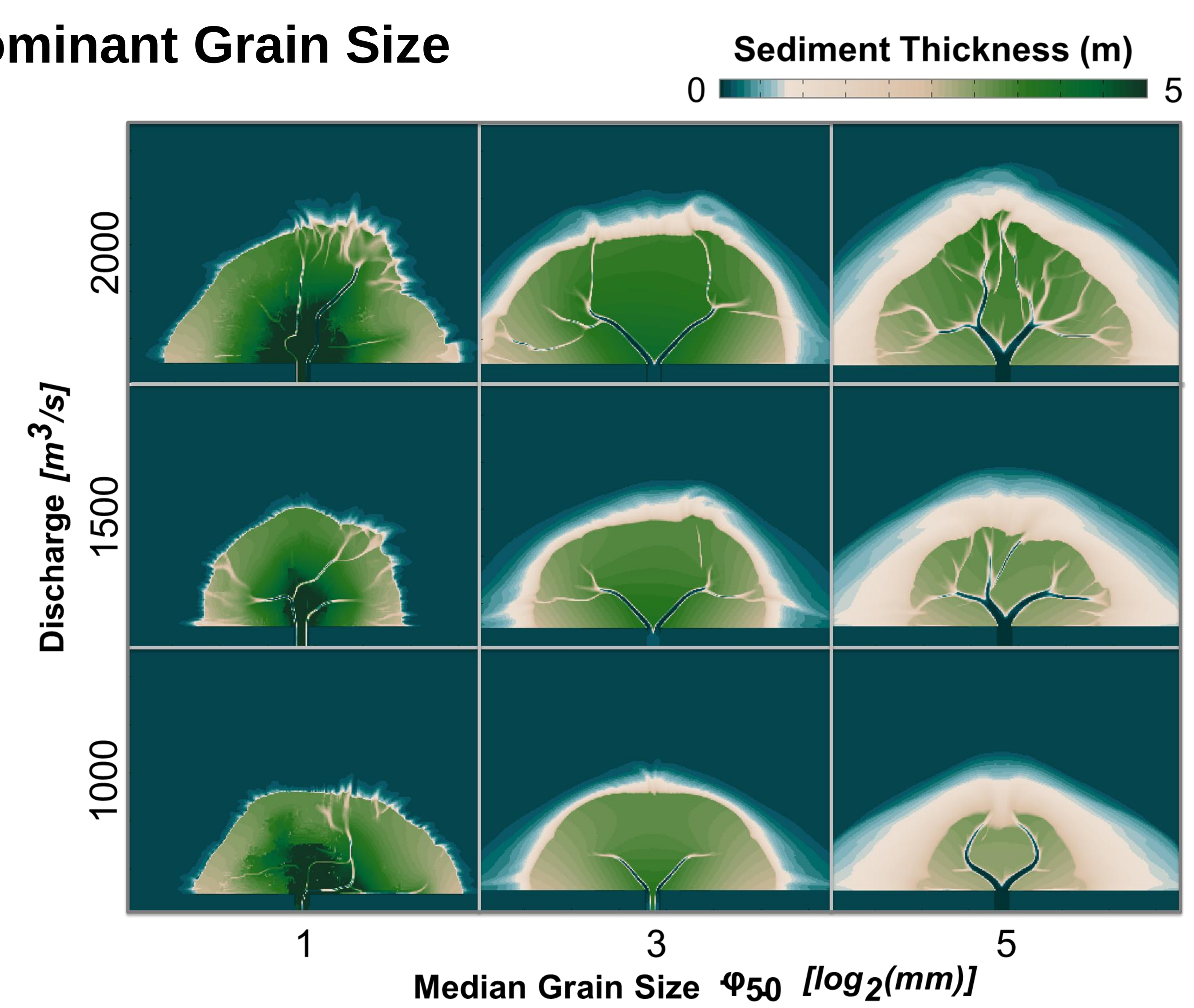
Results

Morphodynamic Forces

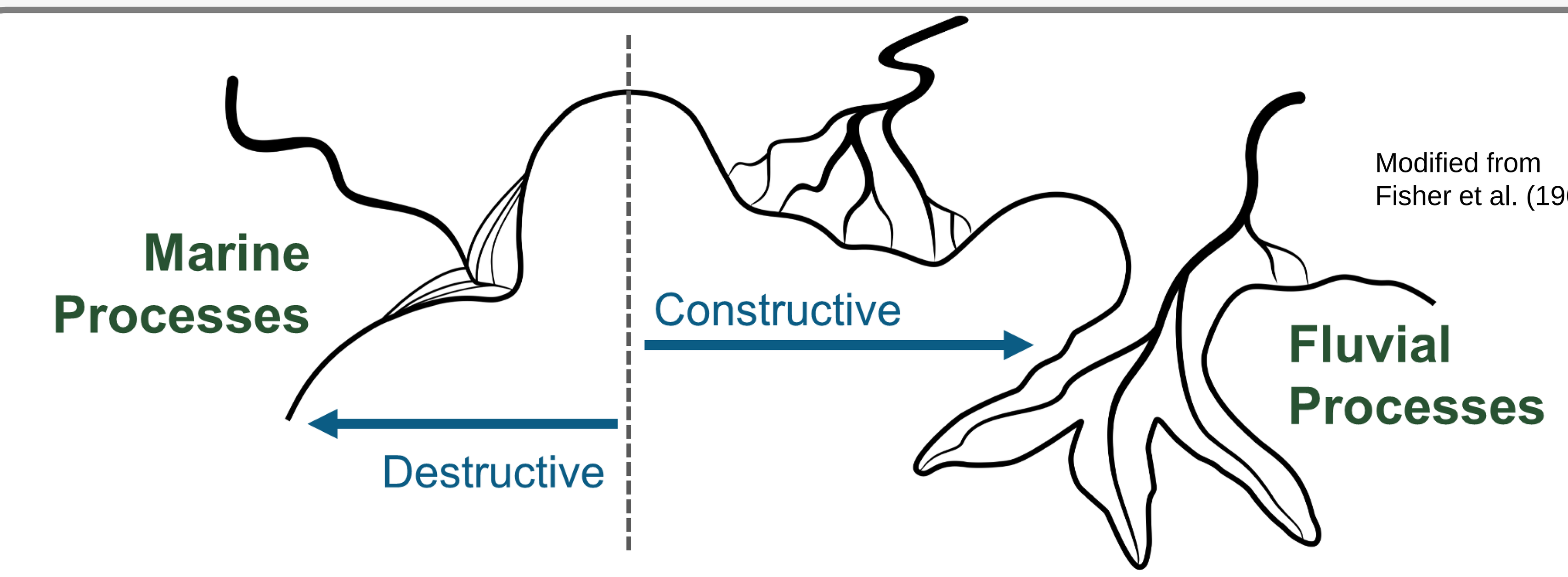


	1	2	3	4	5	6
Discharge ($m^3\ s^{-1}$)	1750	2000	2500	2000	2250	2500
Wave Height (m)	4	1	1	-	-	-
Peak Period (s)	14	4.5	2	-	-	-
Wind Speed ($m\ s^{-1}$)	12	3	2	-	-	-
Wave and Wind Direction (°)	350	350	350	-	-	-
Number of Simulation Steps	70	80	35	90	60	19

Dominant Grain Size



- Larger dominant grain size results in greater sediment thickness, less channel avulsion, and increased delta front rugosity.
- Higher discharge elongates the delta and quickens delta growth.

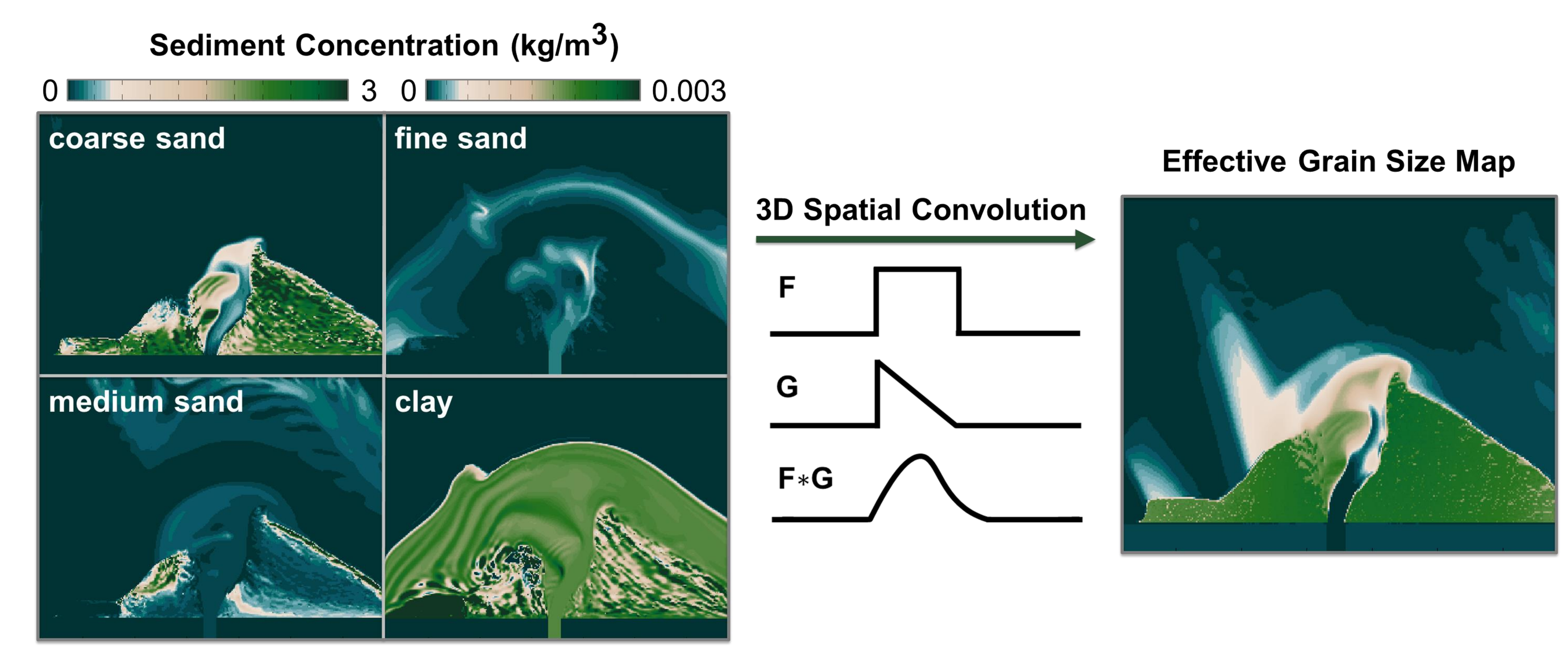


- Increasing wave parameters results in sediment redistribution and slower delta front progradation.
- Increasing fluvial parameters results in fewer channels and faster delta front progradation.

Future Work

Creating the Hydrogeologic Model

Sediment distribution, sediment thickness, and sediment volume fraction output from the morphodynamic models will be used to create the hydrostratigraphic input for the hydrogeologic model.



1. Determine the effective grain size using 3D spatial convolution.
2. Assign aquifer properties based on dominant grain-size.

References

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