Temperature Sensing via Infrared Camera to Identify Groundwater Interactions with Streams

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The myth of spatially uniform/diffuse discharge
Groundwater temperature may be distinct from surface water, and therefore acts as a natural tracer that may be relatively cold and dense in summer...

...and relatively warm and buoyant in the winter, compared to surface water. Groundwater inflows can be identified quickly throughout aquatic systems if there is a surface temperature expression.
Remote sensing surface temperature

Boone aquifer/small tributary in eastern OK
Winter 2017-18
Seep hunting to guide real time sampling/measurements
Rapid advancements in thermal imaging from drones

Cimarron River near Dover, OK (US HWY 81)
Summer 2018
Fiber-optic distributed temperature sensing

Submeter-scale **direct contact** temperature measurements over km cables through time indicate seepage patterns and processes.
Comprehensive geolocation of preferential groundwater discharges
Infrared imaging of discharge: sUAS

- Channel thermal heterogeneity around debris and beaver dams
- Instream groundwater mixing zone
- Discrete groundwater discharges

Preliminary data, not reviewed.
Concurrent, georeferenced data enable integrated analysis of multiple datasets.
Planned Projects in Oklahoma with IR

Major Alluvial Aquifers
- Arkansas River (AR)
- Canadian River (CR)
- Cimarron River (CI)
- Enid Isolated Terrace (EIT)
- Girty Sand (GS)
- North Canadian River (NC)
- North Fork of the Red River (NFR)
- Red River (RE)
- Salt Fork of the Arkansas River (SFA)
- Salt Fork of the Red River (SFR)
- Tillman Terrace (TT)
- Washita River (WR)

Minor Alluvial Aquifers
- Ashland Isolated Terrace (AIT)
- Beaver Creek (BC)
- Cache Creek (CC)
- Chikassee River (CR)
- Fairview Isolated Terrace (FIT)
- Heworth Isolated Terrace (HIT)
- Isabella Isolated Terrace (IIT)
- Little River (LI)
- Loyal Isolated Terrace (LIT)
- Middle Neosho River (MN)
- Northern Neosho River (NN)
- Southern Neosho River (SN)
- Verdigris River (VR)

Major Bedrock Aquifers
- Arbuckle-Simpson (AS)
- Arbuckle-Timbered Hills (AT)
- Blaine (BL)
- Elk City (EC)
- Garber-Wellington (GW)
- Ogallala (OG)
- Roubidoux (RB)
- Rush Springs (RS)
- Varnoosa-Ada (VA)

Minor Bedrock Aquifers
- Broken Bow (BB)
- Cherokee Group (CG)
- East-Central Oklahoma (ECO)
- El Reno (ER)
- Hennessy - Garber (HG)
- Holy Creek (HC)
- Kiamichi (KI)
- Marcella (MA)
- North-Central Oklahoma (NCO)
- Northeastern Oklahoma Pennsylvanian (NOP)
- Pennsylvanian (PE)
- Pine Mountain (PM)
- Post Oak (PO)
- Potato Hills (PH)
- Southwestern Oklahoma (SO)
- Texoma (TE)
- Western Oklahoma (WO)
- Woodbine (WB)

Base Layers
- Counties

*Major groundwater basin (aquifer) is defined as a distinct underground body of water overlain by contiguous land and having substantially the same geological and hydrological characteristics and from which groundwater wells yield at least fifty (50) gallons per minute on the average basinwide if from a bedrock aquifer and at least one hundred fifty (150) gallons per minute on the average basinwide if from an alluvium and terrace aquifer, or as otherwise designated by the Board.

*Minor groundwater basin (aquifer) is defined as a distinct underground body of water overlain by contiguous land and having substantially the same geological and hydrological characteristics and which is not a major groundwater basin.

For more information please visit the OWRB’s web site at: (http://www.owrb.ok.gov)
Questions

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