HYDROGEOCHEMICAL MODELING STUDY TO EVALUATE POTENTIAL FLOWPATHS TO SURFACE WATER BASEFLOW IN LOWER CIENEGA CREEK, PIMA COUNTY, ARIZONA

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UA SCIENCE Hydrology & Atmospheric Sciences

INTRODUCTION

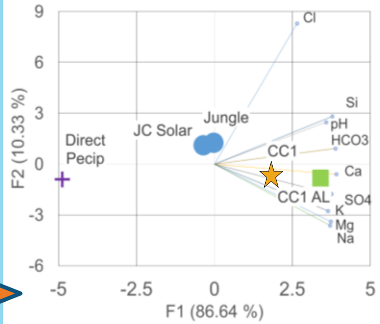
- Surface water baseflow in Cienega Creek Natural Preserve may be impacted by stresses to the system including groundwater pumping and climate change.
- Better understanding sources and their contributions to surface water can aid in management strategies to keep water in the streams.
- Surface water sourced from:
  1) Groundwater can indicate sensitivities to pumping
  2) Direct precipitation can indicate sensitivities to climate change
- This research uses geochemical modeling to investigate contributions to surface water base flow from direct precipitation and basin groundwater (shallow and from deeper sedimentary formations).

METHODS

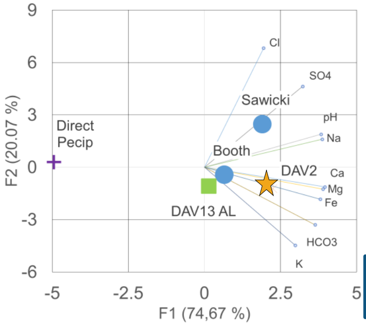
Data Collection

- Surface water, precipitation, and shallow groundwater were collected for this study.
- Well data was incorporated from previous studies.[2]

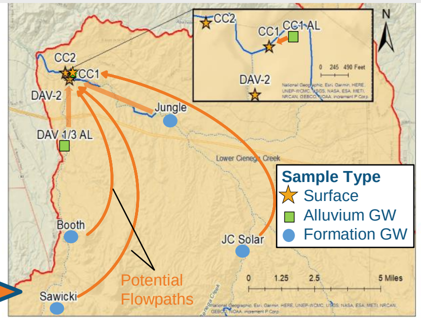
Cienega Creek PCA



Davidson Canyon PCA



Flowpath Selection



- The site conceptual model, previous studies, and Principal Component Analysis (PCA) guided selected flowpaths.
- PHREEQC inverse modeling is used to evaluate geochemical evolution from groundwaters and precipitation to surface water.
- For each model result relative fractions/percent contributions to final waters (CC1, DAV2) are calculated for each initial solution that's included (direct precipitation, alluvium groundwater and deeper groundwaters).

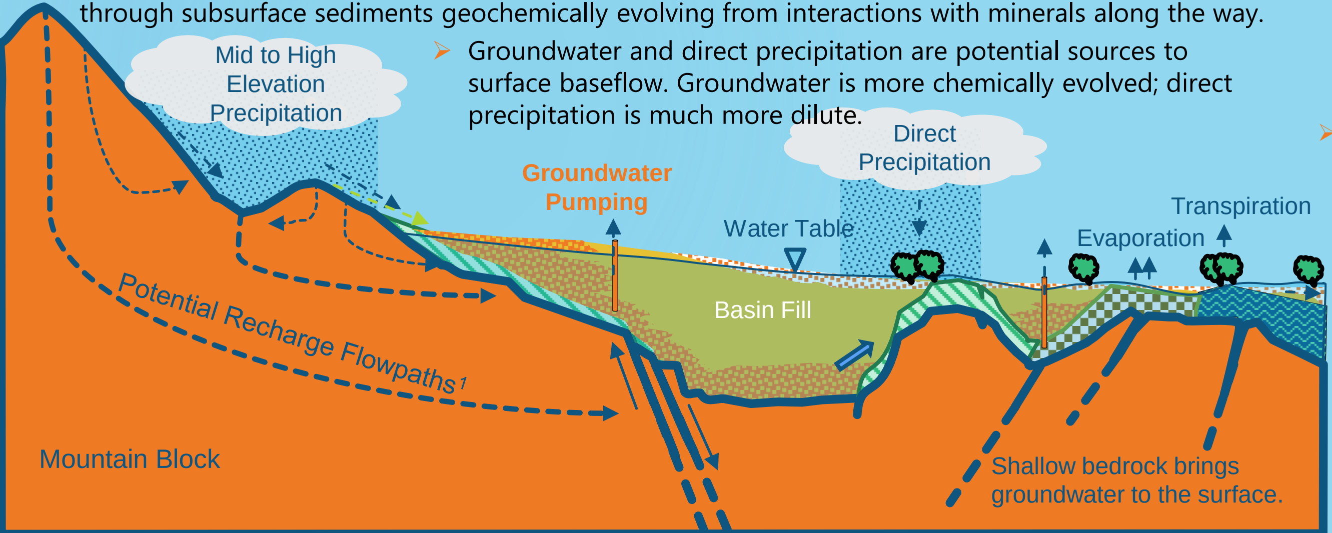
PHASES INCLUDED IN MODEL INPUT

Calcite	Dolomite*	Gypsum*	Anhydrite*	SiO2(a)
Cation Exchange	CO2(g)	K-Spar*	Chlorite	

* Indicates dissolve only; lighter orange only applies to DAV 2

CONCEPTUAL MODEL

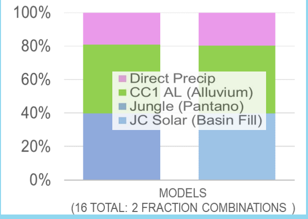
- Cienega Creek watershed rests within the North American Basin and Range Province; sedimentary formations deposited pre-extension are found above bedrock; basin fill and alluvial stream sediments are situated above sedimentary formations.
- Groundwater recharge primarily comes from precipitation in surrounding mountain ranges that travels through subsurface sediments geochemically evolving from interactions with minerals along the way.
- Groundwater and direct precipitation are potential sources to surface baseflow. Groundwater is more chemically evolved; direct precipitation is much more dilute.



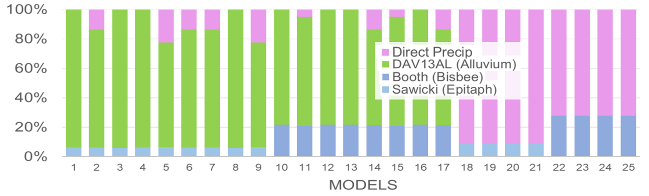
PRELIMINARY RESULTS

- CC1 surface water from 12/13/2019 is primarily groundwater sourced (~80%); with a smaller contribution from precipitation (~20%) CC1.
- DAV 2 surface water from 12/13/2019 is either primarily from alluvium groundwater or direct precipitation with a small fraction of deeper groundwater.

CC1 % Contributions



DAV2 % Contributions



CONCLUSIONS

- Preliminary results indicate groundwater is the primary source to base flow in Cienega Creek and likely Davidson Canyon. Deeper groundwater contributes to surface flow more in Cienega Creek than Davidson Canyon. Direct precipitation is also an important contributor. Additional evaluation is needed.
- For protection of surface water, in Cienega Creek Natural Preserve, water managers should focus on minimizing future groundwater pumping; however, impacts from climate change are also likely.

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Pima County Regional FLOOD CONTROL DISTRICT

References:

1: Markovich, K. H., Manning, A. H., Condon, L. E., & McIntosh, J. C. (2019). Mountain-block recharge: A review of current understanding. Water Resources Research, 55, 8278–8304.

3: Vicenti, N. 2018. Natural Tracer Study to Constrain Transit Times and Flowpaths of Groundwater from Davidson Canyon to Lower Cienega Creek, *Master's Thesis, University of Arizona*.