

# Helium, Nitrogen and Carbon Dioxide Accumulations in the Holbrook Basin, Arizona

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## Abstract

The Holbrook basin of northeastern Arizona contains significant amounts of helium, nitrogen and carbon dioxide in subsurface reservoirs. These gases are not thoroughly mixed but have distinct distributions across the basin. Gas compositions from 47 wells have two groups that stand out; very high nitrogen samples that also have the highest amounts of helium are from the northeast part of the basin, and very high carbon dioxide samples are from the southeast. The higher percentages of helium are over 8%. The higher percentages of carbon dioxide are nearly pure, but most wells have some nitrogen and helium. Both helium and carbon dioxide are found outside the areas of major concentrations, smaller amounts of helium are more widespread.

The distributions of nitrogen and carbon dioxide have an inverse relationship across the basin. The distribution maps show that helium is closely associated with nitrogen. However, the very high helium values along the Pinta Dome trend and to the east certainly stand out. The large amount of helium along these trends must be associated with a uniquely high helium source, or considering its regional down-dip position, significant secondary migration. Helium between 3 and 5% looks widespread. South of Petrified Forest National Park is an area with over 4% helium. To the northwest, the potential is unconstrained by data. Carbon dioxide is primarily located near mafic volcanics at St. Johns, with some extending to the northwest.

The sources and migration history of helium (with nitrogen) versus carbon dioxide are constrained by gas composition data, isotope work, and models from other areas. Helium and nitrogen are associated with several mapped structural trends that may each have a path-way to the lower crustal source. Few of the structures are connected to the source of carbon dioxide in the mantle. The migration model shows equal contributions from local sources of a uniform helium and nitrogen gas mix. Carbon dioxide primarily comes in at St. Johns. The main factor in the distribution of gas in the basin is the tradeoff between nitrogen and helium versus carbon dioxide. The igneous activity associated with the carbon dioxide is relatively recent. During this time, carbon dioxide is diluting the nitrogen and helium in the southeast part of the basin. At the Pinta Dome trend lateral migration is supplementing the helium concentrations. The evidence for aquifer flow is strong, and eight percent helium is very unusual in the region.