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Supporting information for

## **Krypton-81 dating constrains timing of deep groundwater flow activation**

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Table S1 and Table S2

### **Introduction**

This supporting information provides the tables as presented in the main article

**Table S1.** Location and geologic formation of  $^{81}\text{Kr}$  samples

Gas sample ID	Location	Latitude	Longitude	Depth (m)	Period	Formation
PW-12b	Lisbon Valley	38.1246	-109.1209	305	Cretaceous	Burro Canyon Formation (Fm)
PW-8b	Lisbon Valley	38.1478	-109.1345	472	Jurassic	Navajo Sandstone
PW-11b	Lisbon Valley	38.1262	-109.1007	457	Jurassic	Navajo Sandstone
AM-62	Andy's Mesa	38.0305	-108.2685	1711	Permian	Cutler Formation
MM 31-42	Lisbon Valley	38.2318	-109.2099	1613	Pennsylvanian	Honaker Trail Fm
MM 31-31	Lisbon Valley	38.2362	-109.2153	1522	Pennsylvanian	Honaker Trail Fm
Sahgzie 1	Greater Aneth	37.1696	-109.3064	1954	Pennsylvanian	Desert Creek members, Paradox Fm
Monument-8n-2	Greater Aneth	37.3163	-109.1979	1895	Pennsylvanian	Desert Creek members, Paradox Fm
Cane Creek 32	NW of Moab	38.5803	-109.7356	2239	Pennsylvanian	Cane Creek member, Paradox Fm
Lisbon B6-10	Lisbon Valley	38.1980	-109.2773	2369	Mississippian	Leadville Limestone
Lisbon D8-10	Lisbon Valley	38.1902	-109.2687	2441	Mississippian- Devonian	Leadville Limestone - McCracken Sandstone member, Elbert Fm
Lisbon D6-10	Lisbon Valley	38.1981	-109.2695	2370	Devonian	McCracken Sandstone member, Elbert Fm
Lisbon 10-33	Lisbon Valley	38.1915	-109.2737	2702	Devonian	McCracken Sandstone member, Elbert Fm

**Table S2.** Analytical results of  $^{81}\text{Kr}$  and  $^{85}\text{Kr}$  for dissolved/produced gas samples and hydrochemical data of water samples from corresponding wells or geologic formations

Gas sample ID	$^{85}\text{Kr}$ activity (dpm/cc)	$^{81}\text{Kr}$ (pMKr)	$^{81}\text{Kr}_{\text{corrected}}$ (pMKr) <sup>a</sup>	$^{81}\text{Kr}$ age (ka)	Cl/Br	TDS (g/L)	$\delta^{18}\text{O}_{\text{water}}$ (‰, SMOW)	$\delta\text{D}_{\text{water}}$ (‰, SMOW)
PW-12b	4.65 ± 0.4	111.7 ± 2.3	112.5 ± 2.5	Anomaly	73	1.26	-14.66	-109.51
PW-8b	1.04 ± 0.1	92.7 ± 2.5	92.5 ± 2.5	25.8 $^{+9.7}_{-9.4}$	576	0.88	-12.23	-81.61
PW-11b	1.84 ± 0.2	98.2 ± 2.5	98.2 ± 2.6	<23	441	0.70	-17.28	-129.35
AM-62	1.95 ± 0.7	9.4 ± 3.0	6.8 ± 3.2	890 $^{+210}_{-130}$	1725 <sup>b</sup>	11.4 <sup>b</sup>	-12.78 <sup>b</sup>	-99.60 <sup>b</sup>
MM 31-42	10.3 ± 2.1	32.0 ± 4.4	20.3 ± 5.9	530 $^{+110}_{-80}$	463	82.8	-4.48	-46.99
MM 31-31	<1.2	10.2 ± 2.0	C.N.N. <sup>f</sup>	754 $^{+72}_{-59}$	401	171	-5.23	-62.11
Sahgzie 1	23.8 ± 1.5	37.8 ± 3.2	<16	>600	320	255	4.93	-32.88
Monument-8n-2	<5.1	<16	C.N.N.	>600	436	234	4.96	-34.57
Cane Creek 32	58.8 ± 1.7	84.0 ± 3.1	0.7 ± 28.1	Too uncertain	156	334	4.98	-7.57
Lisbon B6-10	<1.4	<2.5	C.N.N.	>1200	1115 <sup>c</sup>	70.3 <sup>c</sup>	-8.20 <sup>c</sup>	-80.65 <sup>c</sup>
Lisbon D8-10	1.5 ± 0.4	9 ± 1.3	7 ± 1.4	878 $^{+74}_{-60}$	743 <sup>d</sup>	123 <sup>d</sup>	-0.98 <sup>d</sup>	-59.64 <sup>d</sup>
Lisbon D6-10	7.9 ± 0.6	10.2 ± 2.1	<2.9	>1200	557 <sup>e</sup>	150 <sup>e</sup>	2.64 <sup>e</sup>	-49.14 <sup>e</sup>
Lisbon 10-33	2.9 ± 1.0	12.9 ± 3.1	9.1 ± 3.5	790 $^{+160}_{-110}$	449	212	0.91	-35.12
Air-1 <sup>g</sup>	70.1 ± 1.9	105.9 ± 4.4	C.N.N.	-	-	-	-	-

<sup>a</sup>  $^{81}\text{Kr}$  corrected for modern air

<sup>b</sup> Averaged data from Greater Aneth oil field; Spangler et al. (1996)

<sup>c</sup> Data from Lisbon Valley: McIntyre 17-21; Kim et al. (in press)

<sup>d</sup> Averaged data from Lisbon Valley: McIntyre 17-21; Lisbon B8-10; Lisbon 10-33; Kim et al. (in press)

<sup>e</sup> Averaged data from Lisbon Valley: Lisbon B8-10; Lisbon 10-33; Kim et al. (in press)

<sup>f</sup> C.N.N.: Correction not needed

<sup>g</sup> The air sample was collected in Aug. 2018 and measured in June 2019.