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Interacting Groundwater 8.-13.9.2024

SGB 55 ANOS

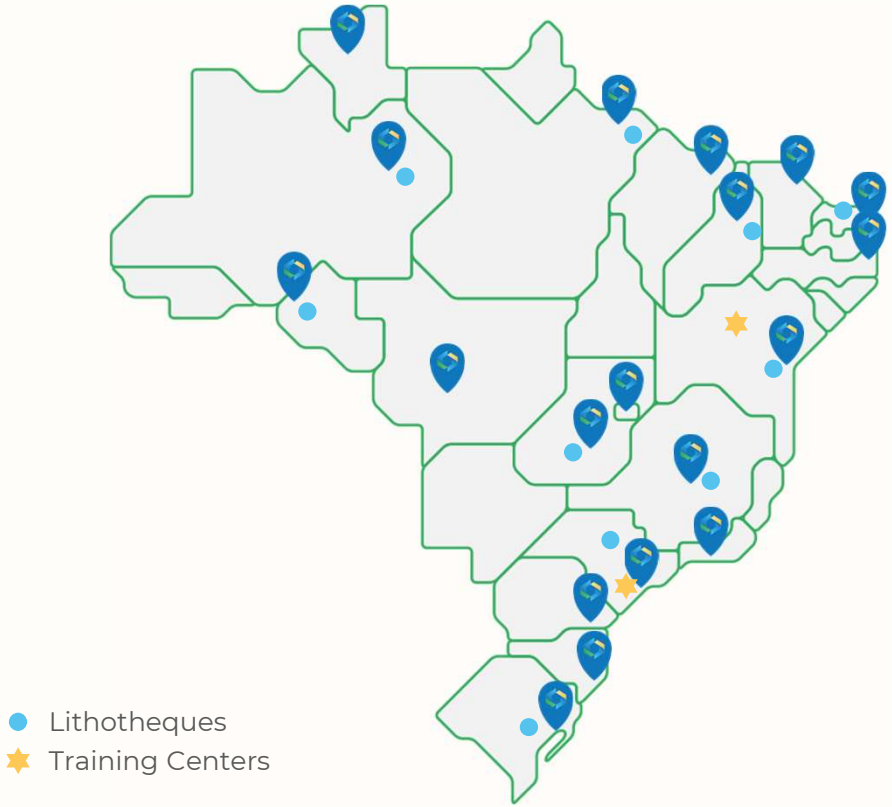
SGB GEOLOGICAL SURVEY OF BRAZIL

NEW FINDINGS USING NOBLE GASES ISOTOPES IN THE GUARANI AQUIFER SYSTEM IN SOUTH AMERICA

Isadora Kuhn, Roberto Kirchheim

SGB GEOLOGICAL SURVEY OF BRAZIL
MINISTRY OF MINES AND ENERGY
BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING

WHO WE ARE



https://geosgb.sgb.gov.br/

Headquarter

Brasília

Main Headquarter

Rio de Janeiro

8 Regional headquarters

Belém, Belo Horizonte, Goiânia, Manaus, Porto Alegre, Recife, Salvador e São Paulo

3 RESIDENCES

Fortaleza, Porto Velho e Teresina

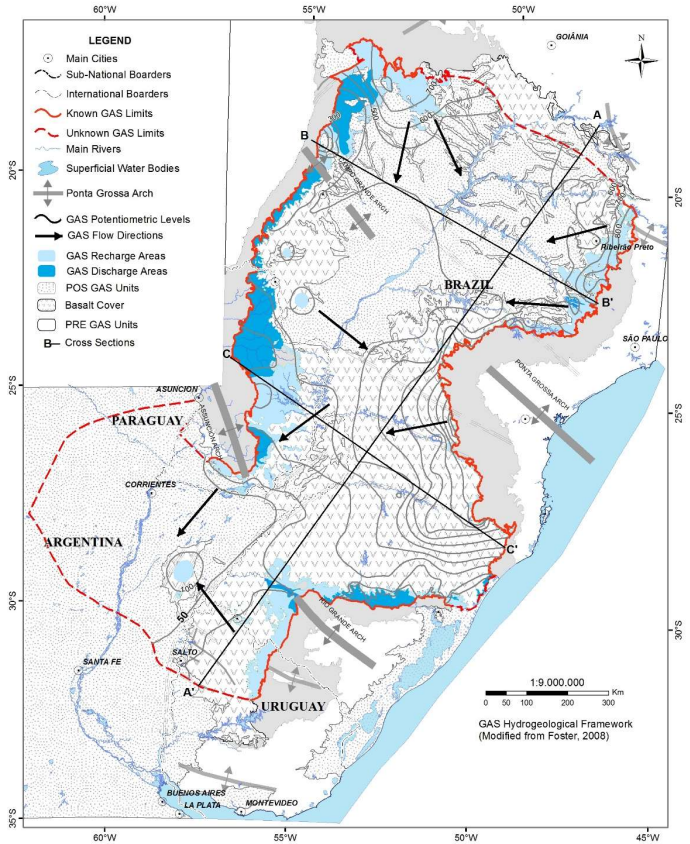
7 Technical Offices

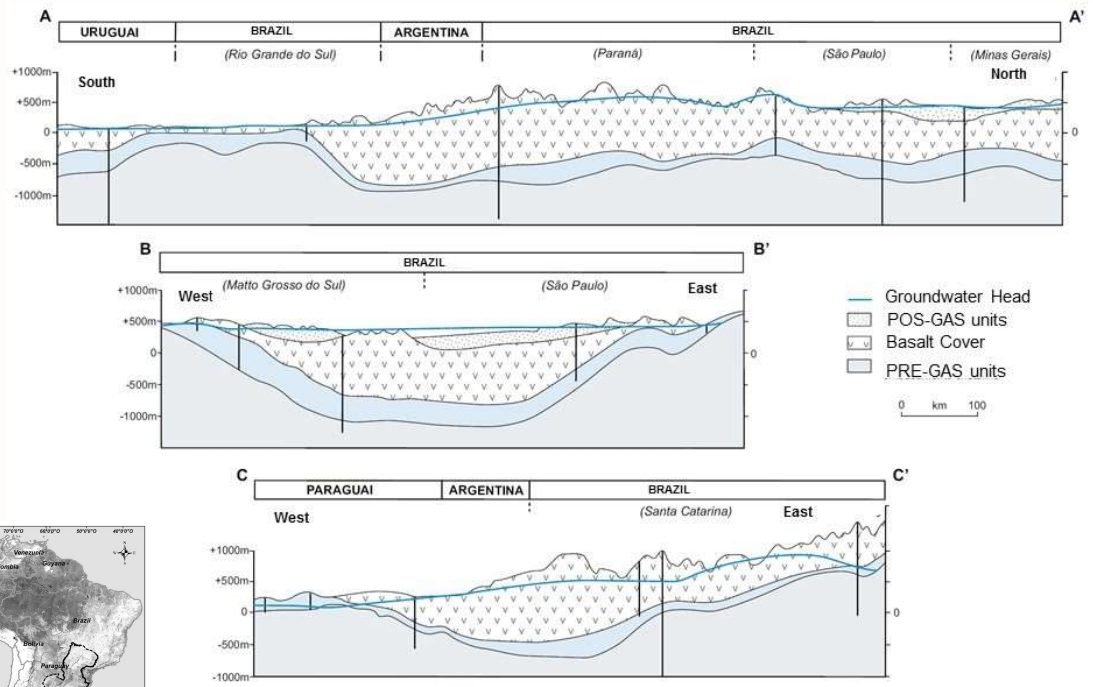
Curitiba, Criciúma, Natal, Cuiabá, Roraima, Palmas e São Luís

CONTEXT

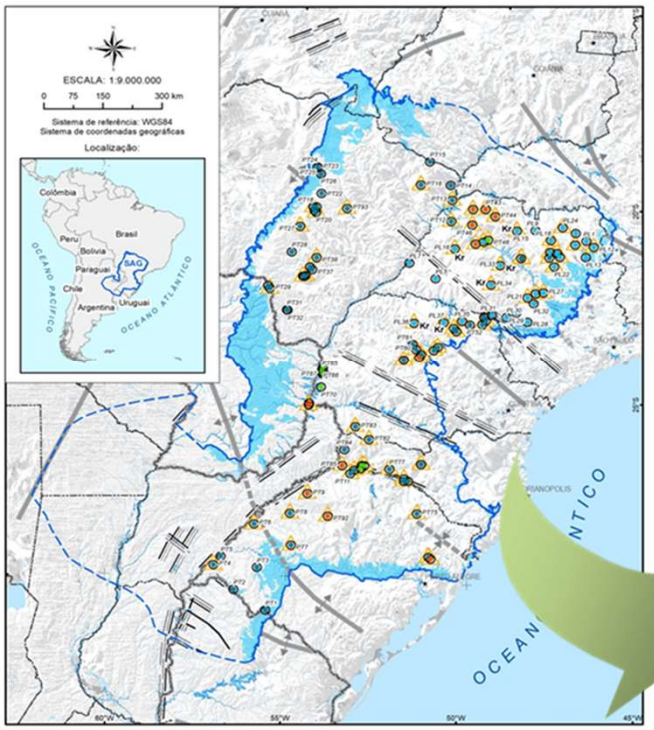
- GAS is a major transbounday aquifer system;
- Target for many national research initiatives;
- First GEF Project on Groundwater Management (World Bank/OAS);
- Treaty ratified by the 4 Countries;
- Intensification of the use;
- IAEA target for aplication of Innovative Isotope Techniques.

THE GUARANI AQUIFER SYSTEM





METHODOLOGY



Characterization of fossil groundwater systems using long-lived radionuclides

2010-2015

Research Project: Complementary Isotopic Studies in the Northern Compartment of the Guarani Aquifer System (Brazil) – Groundwater Dating Along Defined Flow Paths

2017-2020

CRP Title: Complementary Isotopic Studies in the Southern, Western and Eastern Compartments of the Guarani Aquifer System (Brazil) - Groundwater Dating Along Defined Flow Paths'

Improve $^{4}He/^{81}Kr$ chronometer

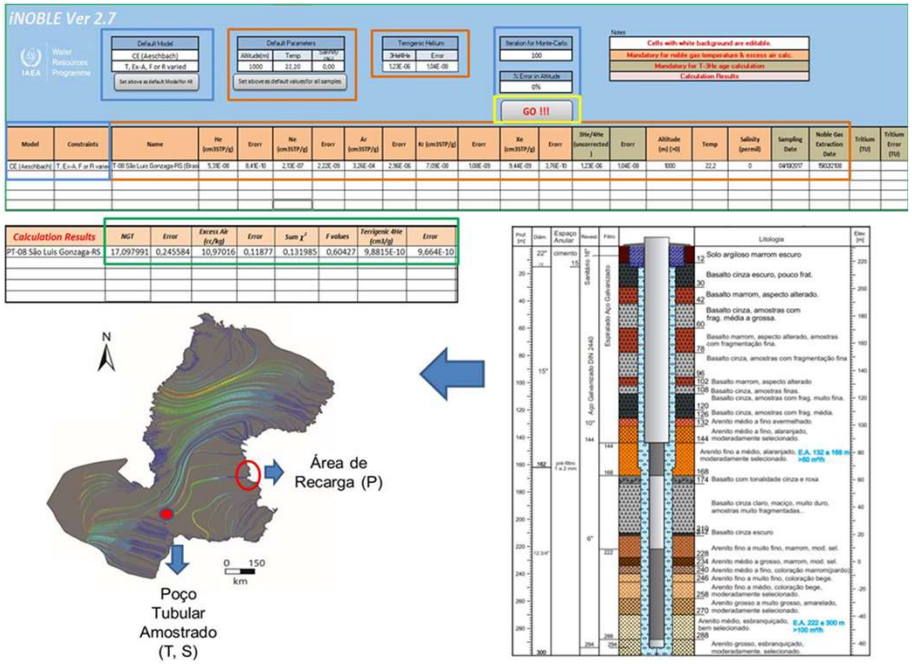
100 NG + 11 ^{81}Kr + Stable Isotopes + Hydrochemistry

METHODOLOGY

Step 1: Sampling of representative and documented GAS deep wells

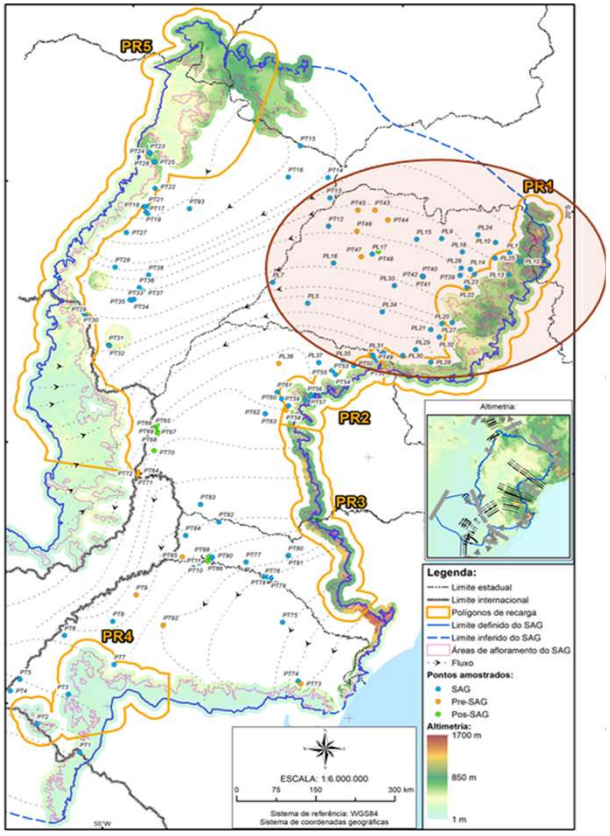
Constructive heterogeneity and uncertainties; difficulties in obtaining laminar flow; shipment challenges

Step 2: NG analysis # INOBLE2.7 modeling # GAS regional conceptual model

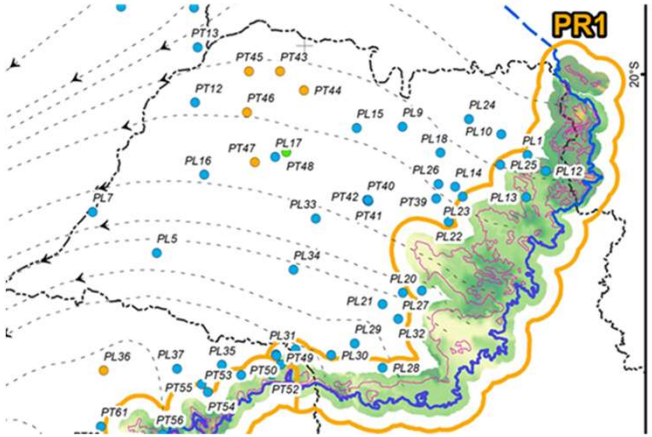


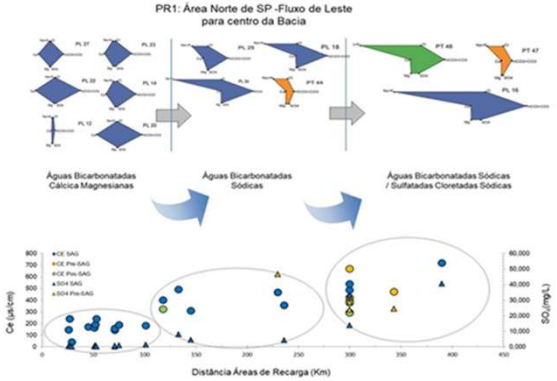
TDS, T, Altitude, NG concentrations

METHODOLOGY



Step 3: Delineation of recharge polygons

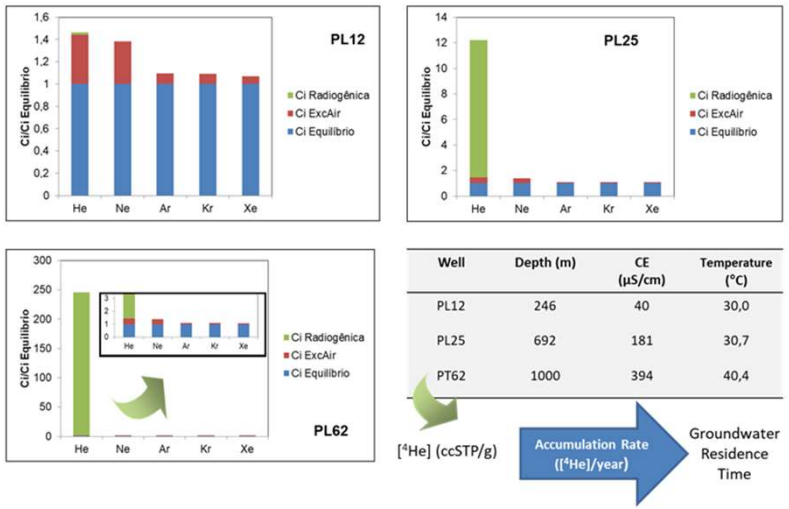




Hydrochemical evolution of the GAS waters
>Na, SO4, Cl, CE, Temp

METHODOLOGY

Step 4: NG Component Separation

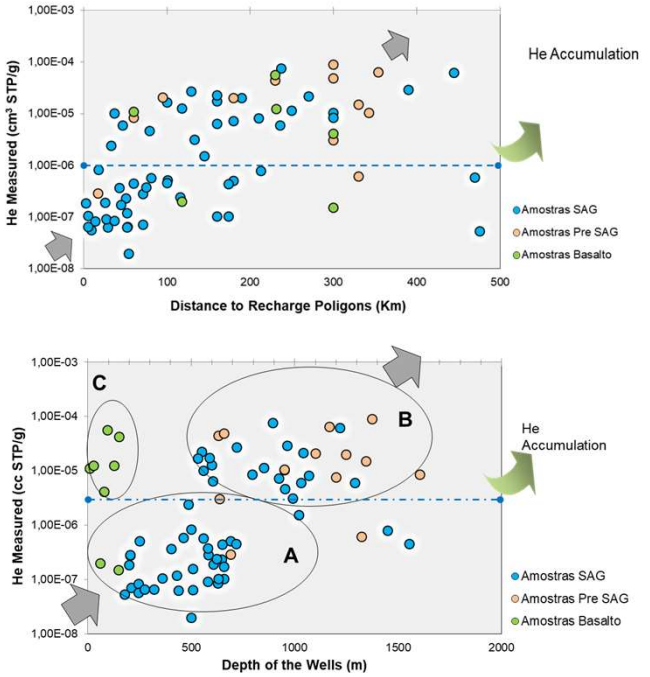


Well	Depth (m)	CE (µS/cm)	Temperature (°C)
PL12	246	40	30,0
PL25	692	181	30,7
PT62	1000	394	40,4

[⁴He] (ccSTP/g) → Accumulation Rate ([⁴He]/year) → Groundwater Residence Time

Significant gradients in ^{4}He rad concentrations, proportional to residence time.

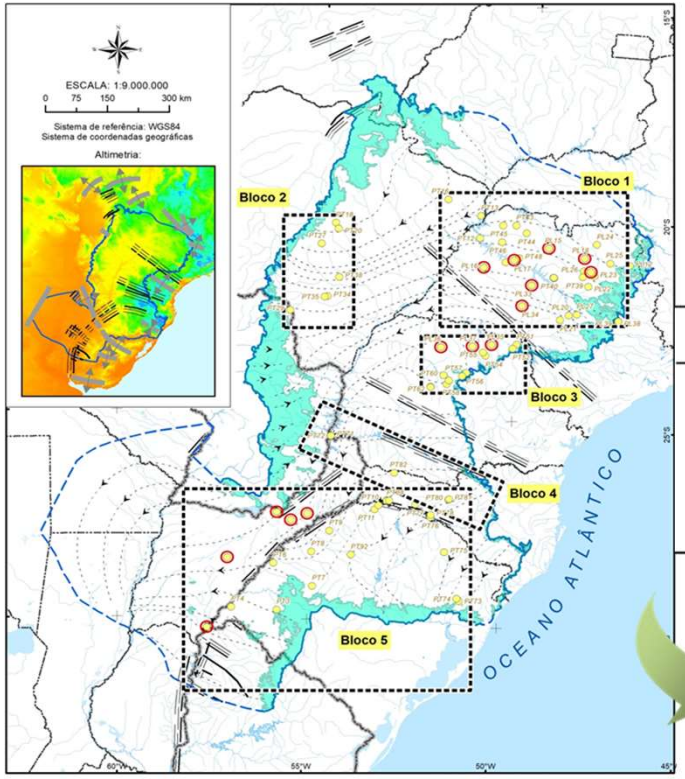
Step 5: ^{4}He distribution across the SAG



Increase of ^{4}He rad and accumulation trends

METHODOLOGY

Step 4: Estimate residence time: use of the chronometer ^{81}Kr-^{4}He rad.

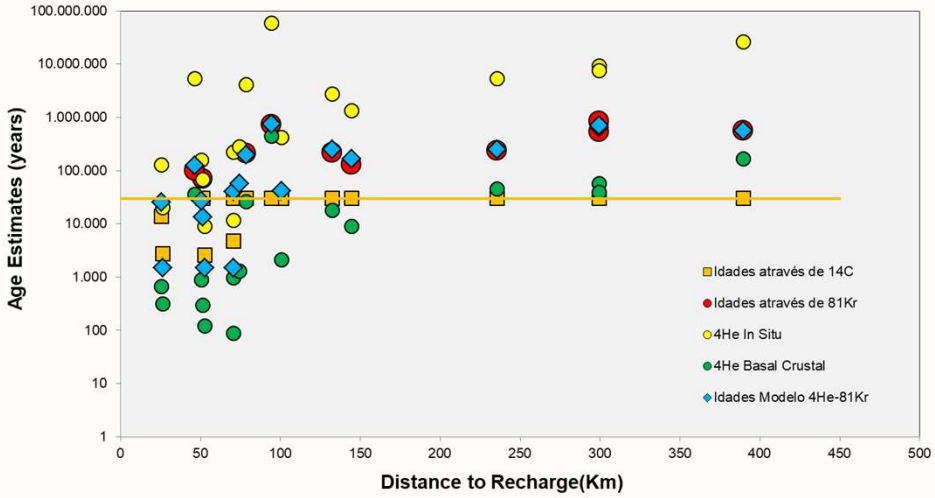


Block Discretization in order to find the best fit for the **Basal Fluxes** and **Vertical Diffusion**

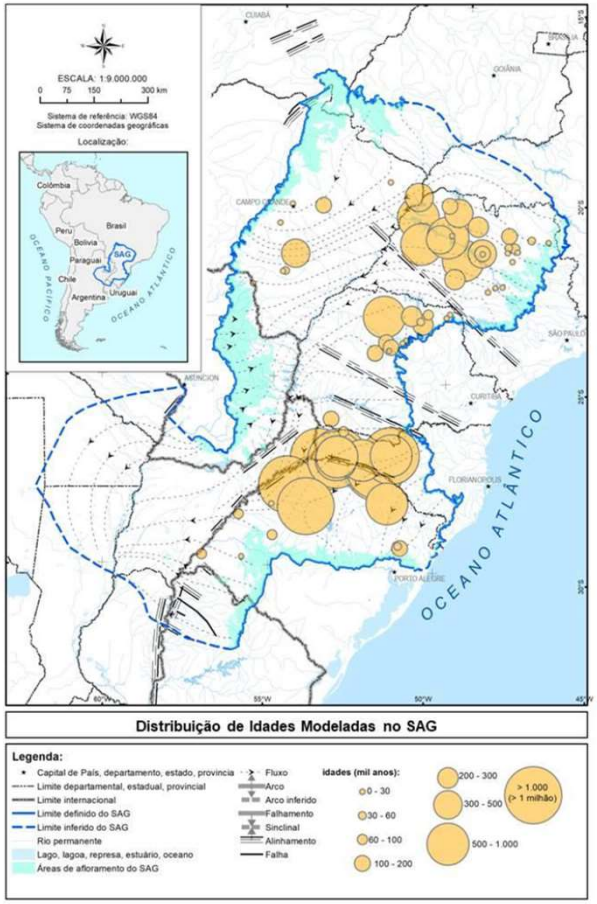
Blocos	Agrupamentos de Blocos	F - Fluxo Basal ($cm^3/cm^{-2}ano^{-1}$)	D_{He} - Difusão Vertical (m^2/s)
1	Aggarval et al., 2014	$2,3x10^{-7}$	$1,0x10^{-9}$
1 e 2	Norte	$1,8x10^{-7}$	$5,3x10^{-10}$
3	Central	$2,0x10^{-7}$	$1,6x10^{-10}$
4 e 5	Sul	$4,1x10^{-8}$	$2,6x10^{-10}$

GAS block discretization to find best fit with ^{81}Kr absolute ages
(basal fluxes and vertical difusion (Torgersen & Ivey (1985)

RESULTS



Validating ^{4}He dating method using ^{81}Kr

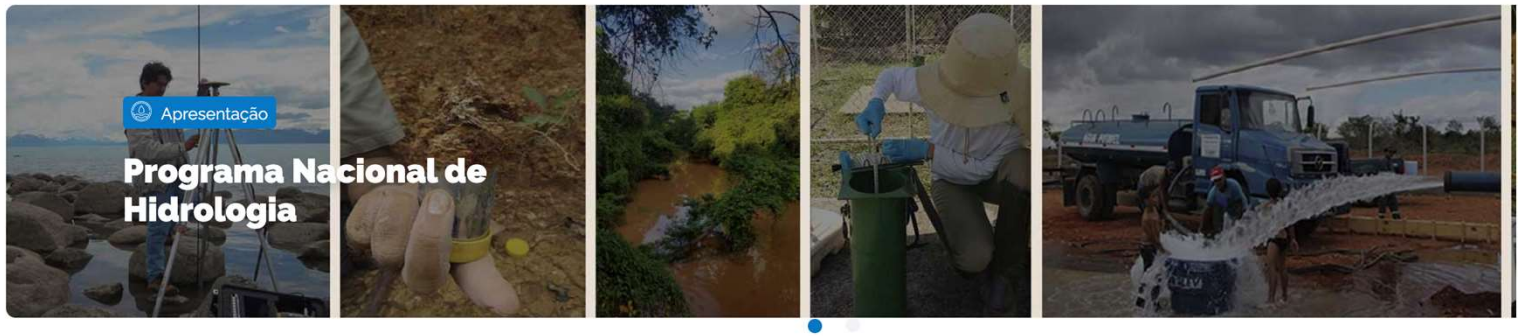


Modeled residence tomes with the ^{81}Kr-^{4}He rad chronometer

CONCLUSIONS

- ✓ Agreement of 20% between the modeled ages $^{4}He/^{81}Kr$ and the absolute ^{81}Kr ages;
- ✓ He in situ accumulation rates proved to produce overestimated groundwater ages;
- ✓ Reference values for He crustal flows at craton areas resulted in underestimate ages;
- ✓ The dating technique with ^{4}He can be considered a quantitative approach when model parameters can be calibrated with an absolute dating. In this case, the He- Kr chronometer proved to be efficient and sufficiently robust.
- ✓ The differences between NGT at the LGM and current temperatures shows average cooling (Δt) on the order of 4°C.
- ✓ The new modeled age distribution, therefore, may be a huge step towards the sound management of this common transboundary aquifer.

CONCLUSIONS



Apresentação

Hidrologia

O Serviço Geológico do Brasil - SGB, através do Programa Nacional de Hidrologia do Departamento de Hidrologia - DEHID, realiza atividades de levantamento básico, administração de base de dados, estudos interpretativos e difusão de conhecimento hidrológico e hidrogeológico. Com atuação em todo o território nacional, proporciona, através de ações extensivas, o suporte à gestão dos recursos hídricos e a prevenção de desastres naturais.

O DEHID é composto por três unidades técnicas e executoras, conforme a seguir:

Divisão de Hidrologia Básica – DIHIBA
Divisão de Hidrologia Aplicada – DIHAPI
Divisão de Hidrogeologia e Exploração – DIHEXP

www.sgb.gov.br

Hidrologia e Hidrogeologia

REDE HIDROMETEOROLÓGICA NACIONAL - RHN

Monitoramento Hidrológico

REDE INTEGRADA DE MONITORAMENTO DAS ÁGUAS SUBTERRÂNEAS - RIMAS

Monitoramento Hidrogeológico

SISTEMA DE ALERTA DE EVENTOS CRÍTICOS - SACE

Monitoramento, Previsão e Manchas de Inundação

SISTEMA DE INFORMAÇÕES DE ÁGUAS SUBTERRÂNEAS - SIAGAS

Gestão da Informação Hidrogeológica

ATLAS PLUVIOMÉTRICO E ESTUDOS DE CHUVAS INTENSAS

Isoietas, Equações IDF

CARTOGRAFIA HIDROGEOLÓGICA

Mapas para Download e WebGIS

MONITORAMENTO HIDROLÓGICO POR SENSORIAMENTO REMOTO

Investigação da Dinâmica Fluvial em Grandes Bacias Hidrográficas

ESTUDOS HIDROLÓGICOS E HIDROGEOLÓGICOS INTEGRADOS

PAN, Ucuruia, Áreas Metropolitanas, Estudos no Verde Grande e Carinhanha

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THANK YOU
OBRIGADA!

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