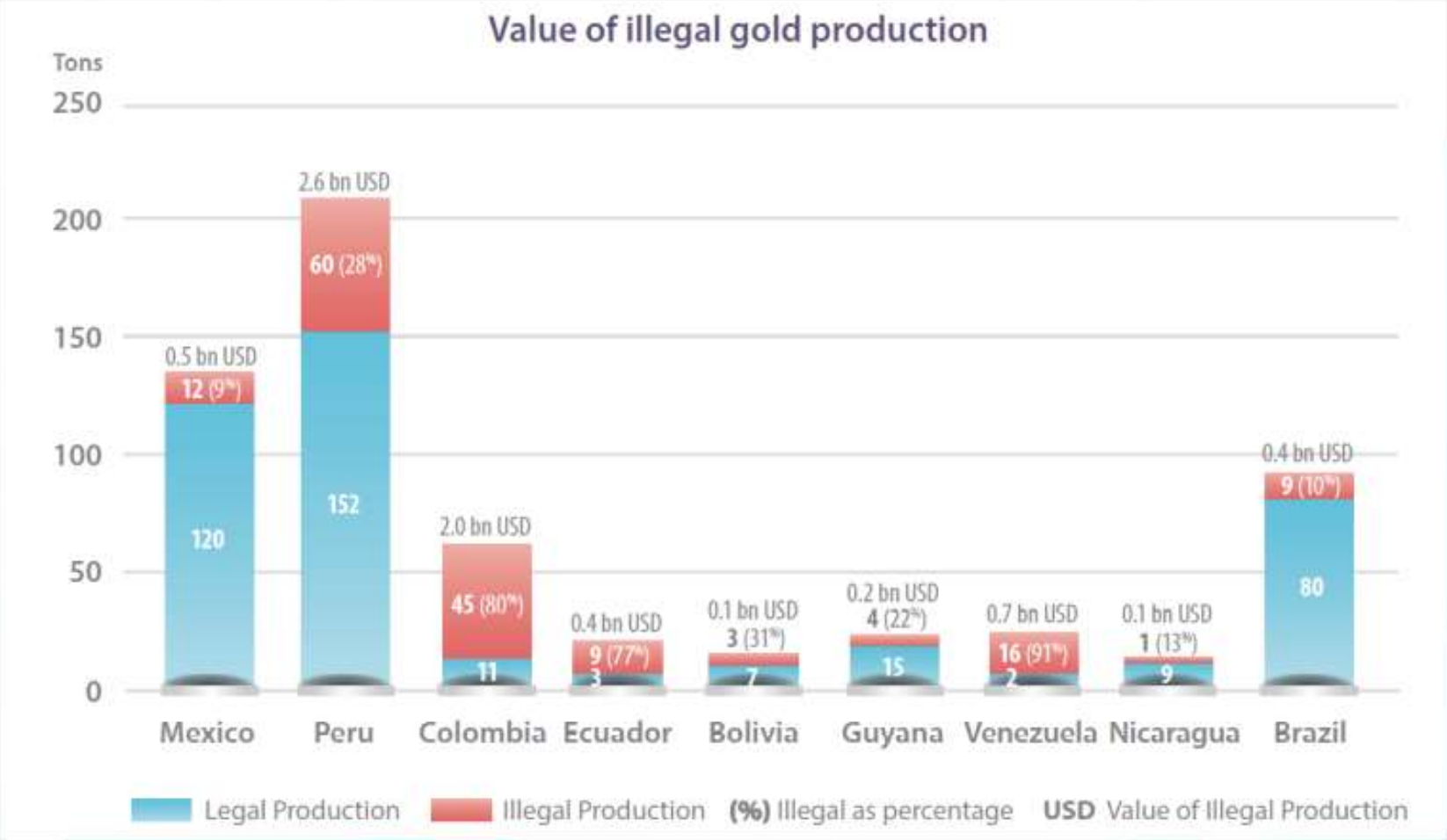
Programa Ouro Alvo
Clean Gold Program

M. Sc. **ERICH** ADAM MOREIRA LIMA
Perito Criminal Federal
Federal Forensics Expert

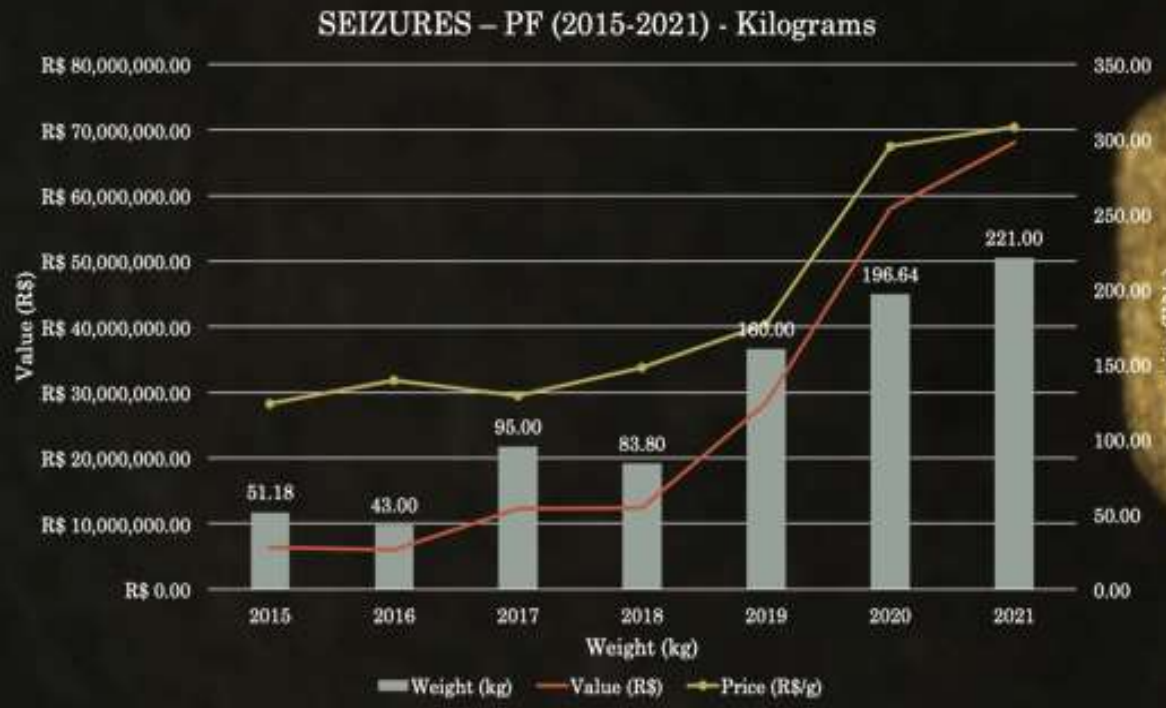
+ 55 63 99265-5005
erich.eaml@pf.gov.br
linkedin.com/in/erich-adam-9413a248
Chefe do Setor de Perícias em Geologia | *Head of Forensic Geology Sector*
Instituto Nacional de Criminalística, Brasília/DF - Brasil | *National Institute of Criminalistics*

Illegal gold productions in Latin America



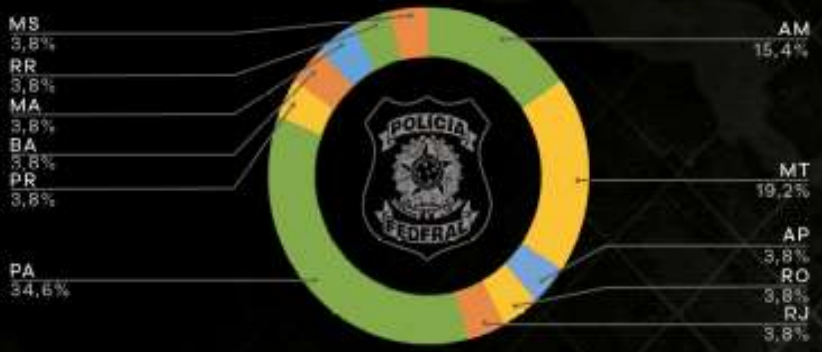
The Global Initiative Against Transnational Organized Crime – "Organized Crime and Illegally Mined Gold in Latin America" (2016).

Context


SEIZURES – PF (2015-2021) - Kilograms
R$ 80,000,000.00
R$ 70,000,000.00
R$ 60,000,000.00
R$ 50,000,000.00
R$ 40,000,000.00
R$ 30,000,000.00
R$ 20,000,000.00
R$ 10,000,000.00
R$ 0.00
Value (R$)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
price (R$/g)
51.18
43.00
95.00
83.80
160.00
196.64
221.00
2015
2016
2017
2018
2019
2020
2021
Weight (kg)
Weight (kg)
Value (R$)
Price (R$/g)

Context

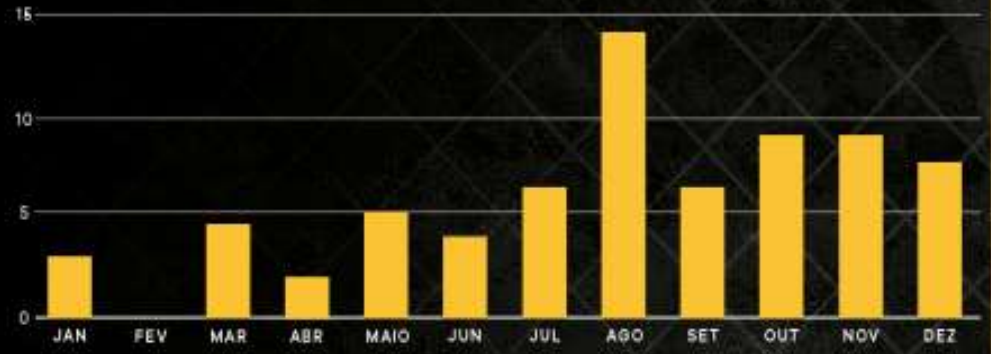
Operações por UF



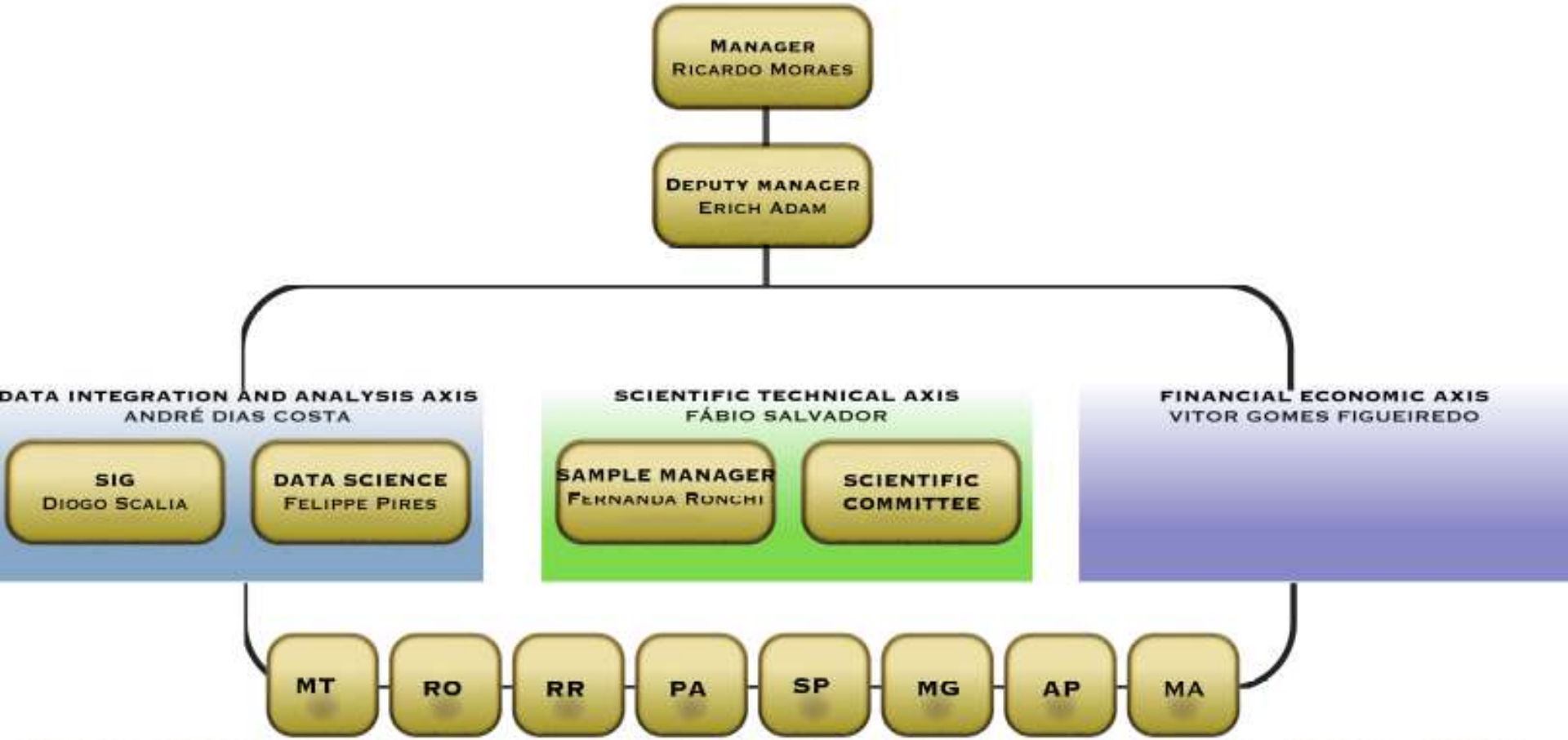
Alertas por Municípios

Áreas	Número de alertas	Rank
ITAITUBA-PA	24729	1
JACAREACANGA-PA	9724	2
OURILÂNDIA DO NORTE-PA	3796	3
CUMARU DO NORTE-PA	3100	4
JAPURÁ-AM	2012	5
NOVO PROGRESSO-PA	1653	6
MAUÉS-AM	1297	7
ALTAMIRA-PA	1037	8
IRACEMA-RR	829	9
NOVA BANDEIRANTES-MT	661	10

Número de Operações por mês no ano de 2021



Organizational Chart



Gold Rush

- **UnB, USP, IRD (France)**
- **Master, PhD Scolarships Characaterization and analysis**
- **Post Doctorate – Pb isotope analysis**

Samples

	ILLEGAL MINING	LEGAL MINING
State	Number of seized gold	Samples collected in the campaigns
PA	150	0
SP	139	0
AP	26	34
AM	22	0
MA	11	0
RJ	9	0
RR	8	0
GO	4	0
MT	3	87
PR	3	13
SUBTOTAL	375	134
TOTAL	509	

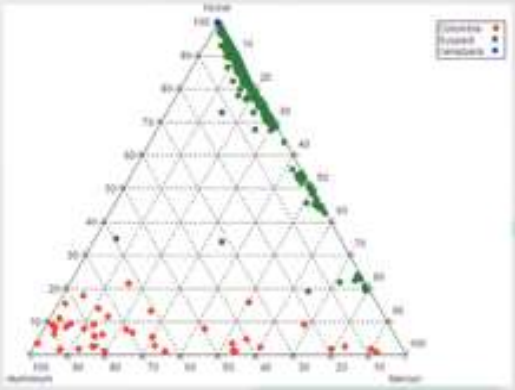
“Gold Library”

“Gold Library”

References

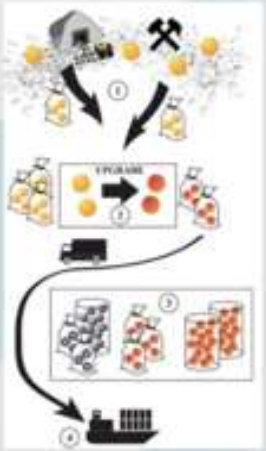
Roger Dixon (Universidade de Pretória)

Determinação de origem em casos criminais
#Projeto baseado em pesquisa acadêmica e procedimentos investigativos



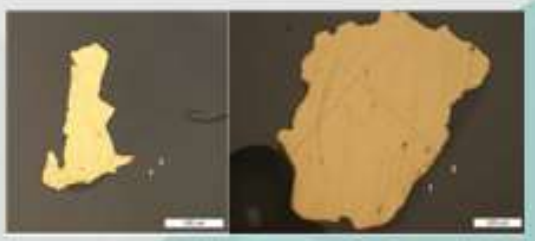
BGR

#Ferramenta científica para verificação de minerais 3T da África
Projeto financiado com recursos da ONU

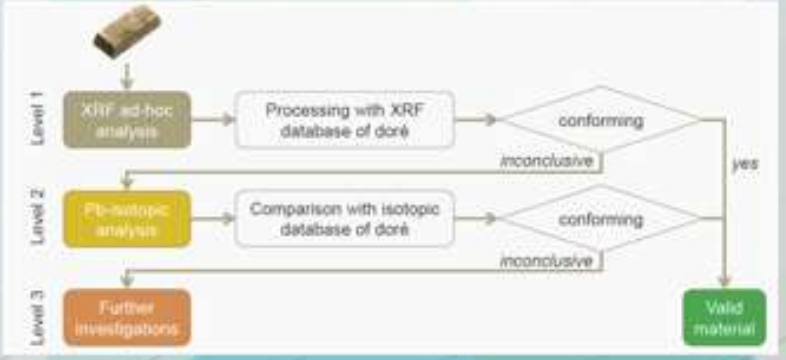


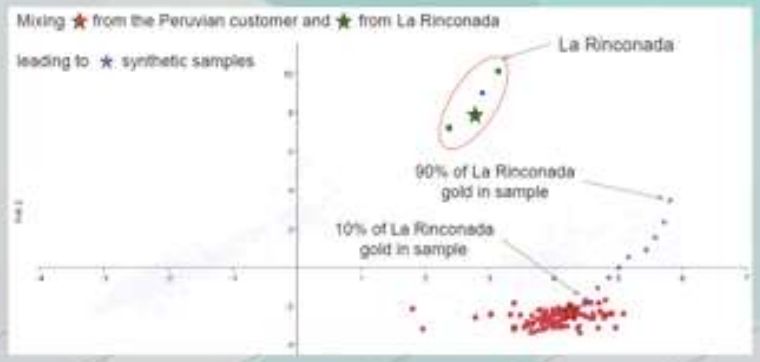
BRGM

Determinação de origem do ouro da Guiana Francesa e Suriname.
Iniciativa da WWF

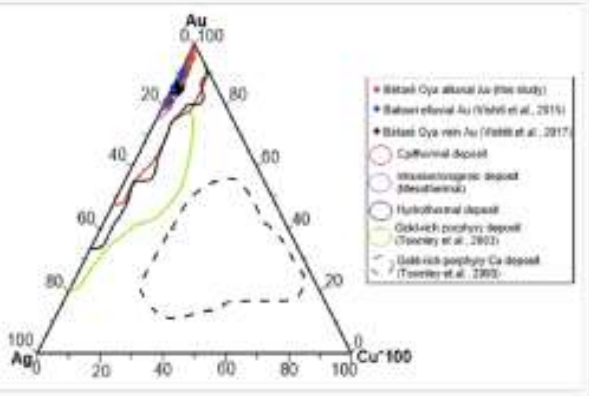


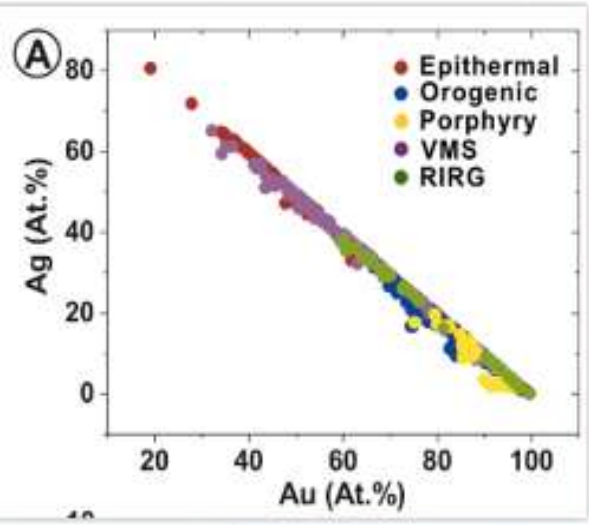
Universidade de Lausane e Metalor
GEOFORENSIC PASSPORT





References





FUNDAMENTAL PROCESS	SYSTEM	CLASS	TYPE	BRAZILIAN EXAMPLES
Igneous (or orthomagmatic)	Ultramafic Mafic Intrusions	magmatic sulfides	Komatiite	Fortaleza de Minas
Sedimentary	Clastic	Placer	Fluvial, alluvial, deltaic, colluvial	Tapajós, Rio Madeira
		Paleoplacer	Fluvial, alluvial, deltaic, colluvial	Jacobina, Moeda, Castelo dos Sonhos
Hydrothermal	Hydrothermal Magmatic	Associated with volcanism	High sulfide epithermal	Botica - V3
			Low sulphide epithermal/ark.	Chapeu de Sol, Castro
			Intermediate sulfide epither.	Coringa
			VMS	Nova Brasilândia,Palmeirópolis,Aripu.
			Auriferous VMS	Zacarias, Digo Digo
		Related to granite intrusions	Porphyry	Juruena, Chapada
			Non-porphyry	Juruena, Breves
			Reduced intrusions	Fazenda Nova, Seridó?
			Skarn	Seridó
			Carbonate Replacement, Veins and Polymetallic Veins	
	hybrid or without clear association with magmatism	Orogenic	Epizonal	Gurupi, GF
			Mesozonal	Gurupi,Itapicuru,GF,Rio Maria,Paracatu
			Hypozonal	Pitangui, Troia
		Carlin		
		IOCG (Iron Oxide Copper Gold)	Orogenic	Sequeiro, Salobo
			Post-Orogenic	
			Andean Continental Margin	
		ISCG (Iron Sulfide Copper Gold)	Orogenic	
			Post Orogenic	
			Andean Continental Margin	
		IOA (Iron Oxide Apatite)	IOA	
	Hydrothermal Sedimentary	Base or precious metals in clastic sediments	SEDEX	Vale do Ribeira
Superficial	Detrital		Eluvial-colluvial	Several
	Supergenic		In situ enrichment	Morro do Mina
			Gossan	Igarapé Bahia, Nova Brasilândia

A

① Field — **Niton™ XL3t XRF Analyzer**

② Laboratory — **DVM6 Digital Microscope**

RECYCLED

ASM

LSM

B

① Satellite Image + Mining Agency

② Laboratory — **DM6 M LIBS**; **Phenom™ XL SEM**; **Micro CT**

IDENTIFIED

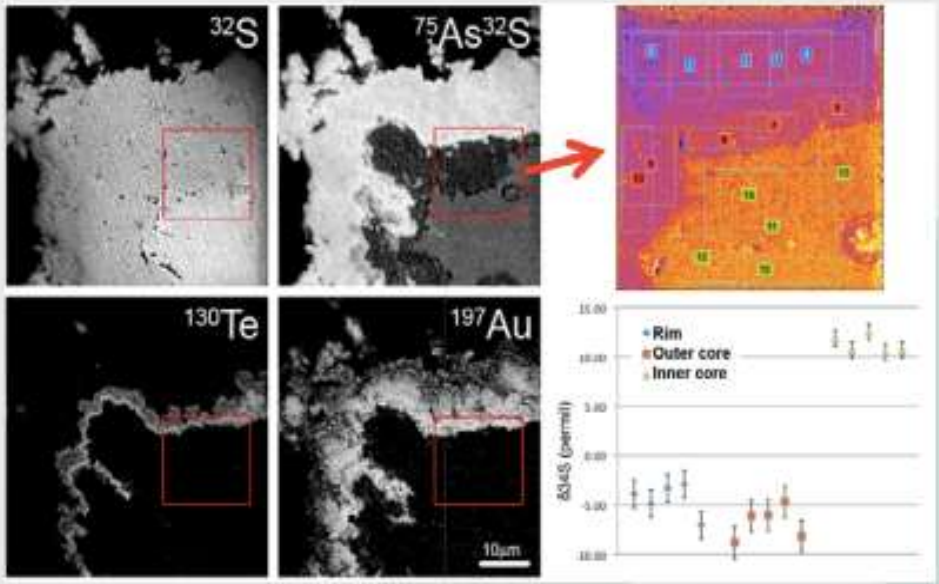
UNIDENTIFIED

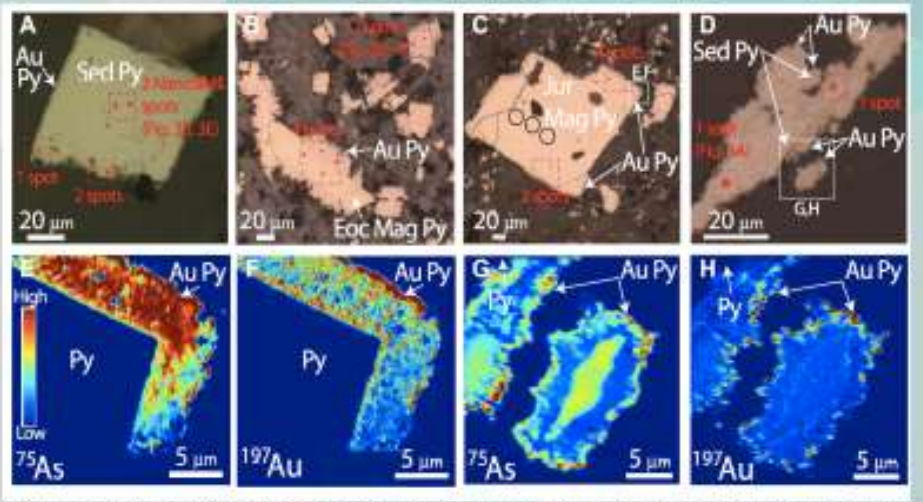
C

① LA-ICP-MS (University of Brasilia and University of São Paulo)

② Nano SIMS (?)

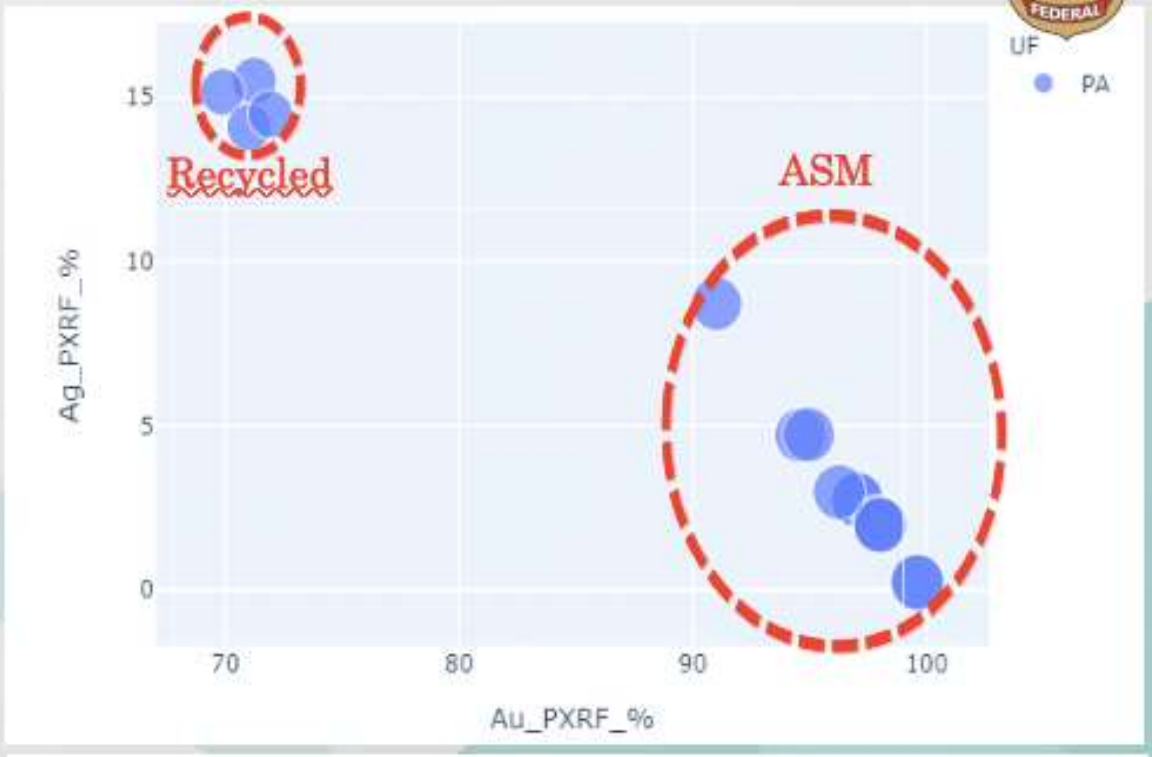
C Nano SIMS (?)





Holley, E.A., et al., 2022, Nanoscale isotopic evidence resolves origins of giant Carlin-type ore deposits: Geology, v. 50, p. 660–664, https://doi.org/10.1130/G49888.1

BANPA

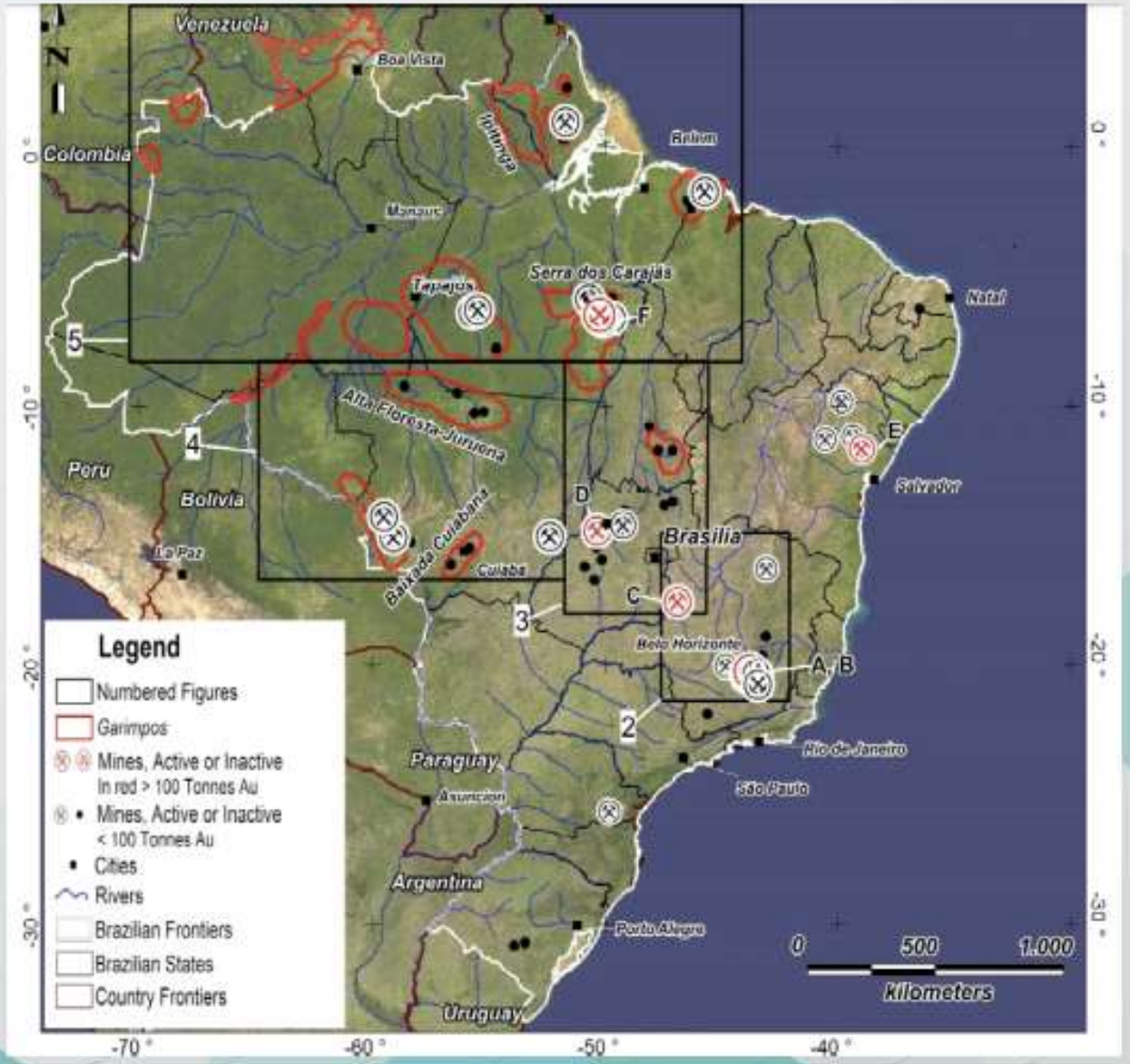


National Gold Profile Database

Geochemical and isotopic data management tool

Sampling Campaigns

References



Main gold districts in Brazil:

i. Iron Quadrangle

ii. Goiás and Tocantins

iii. Mato Grosso and Rondônia

iv. Amazonas, Pará and Amapá

v. Maranhão and Rondônia

A and B - Morro Velho and Cuiabá

C - "Morro do Ouro"

D - Crixás

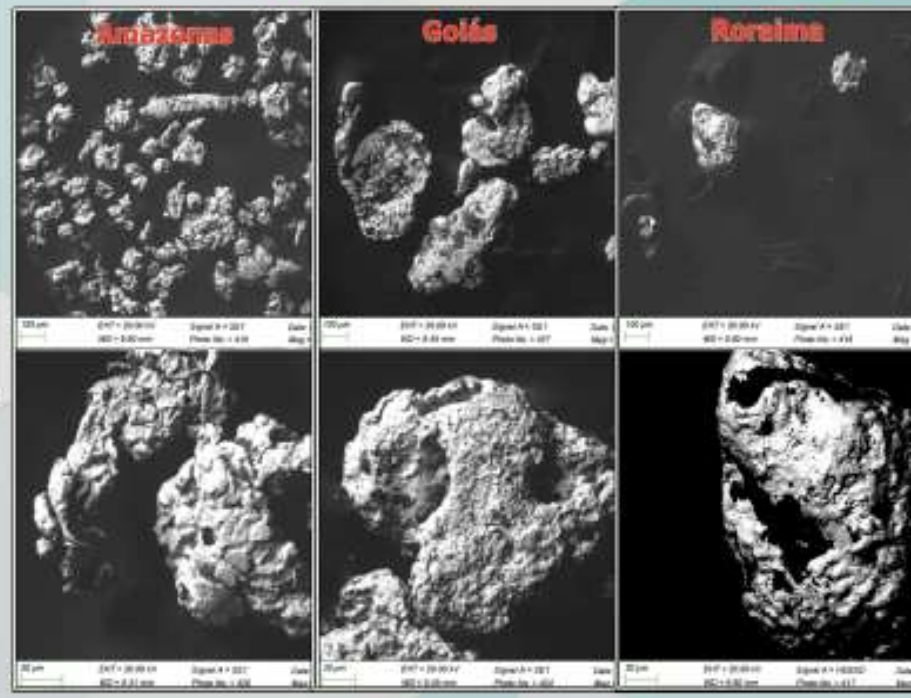
E – "Fazenda Brasileiro"

F - "Igarapé"

Costa and Rios, 2022.

Gold Atlas

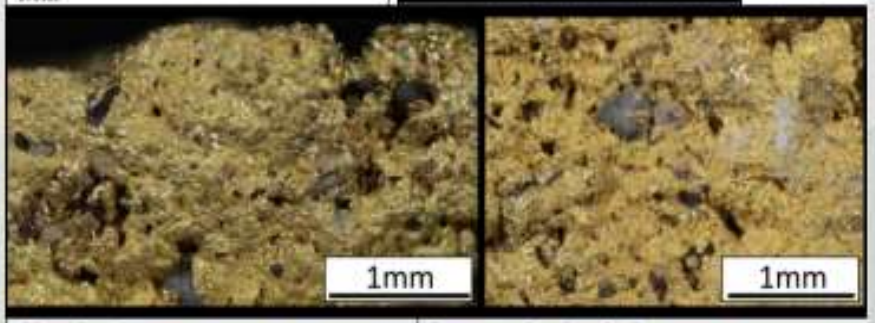
Gold Morfology



BANPA
Programa Ouro Alvo

Amostra 2022_INC_000003

Sistema Eletrônico de Informações (SEI)[1]	
Processo	[redacted]
Sistema Nacional de Criminalística (SISCRIM)[2]	
Registro	[redacted]
Material[3]	[redacted]
Material original[4]	[redacted]
Laudo[5]	[redacted]
Investigação[6]	
Ofício	[redacted]
IPL	[redacted]
Termo de Apreensão	[redacted]
Apreensão	[redacted]
Data da apreensão	[redacted]
Item	[redacted]



Classificação	Percentual estimado de ouro
Esponjas de grãos de ouro mineral	94,52%
Fonte	**Massa**
Garimpo	5,73 gramas

Características

Material mineral disposto na forma de aglomerados granulares porosos, parcialmente fundidos, de dimensões milimétricas a centimétricas, formas irregulares, bordas arredon e textura esponjosa, formado, majoritariamente, por grãos de ouro selecionados e, subordinadamente, por grãos minerais não auríferos esparsos incrustrados. Na superfície possui material residual do processo de queima para retirada do amalgamador.

Conteúdo mineral predominante

Ouro mineral: grãos minerais metálicos, dourados, submilimétricos, irregulares, traço dourado, baixo grau de dureza e maleáveis, dispostos na forma de aglomerados ou esparsos.

Conteúdo mineral secundário

Minerais resistatos residuais: grãos de minerais vítreos ou metálicos, submilimétricos a milimétricos, cores variadas, formas irregulares e bordas arredondas com características de minerais abrasados incrustados nos aglomerados.

Tipo de depósito

Possui características compatíveis com material de origem aluvionar.

Beneficiamento

Processamento simplificado com concentração gravimétrica física, separação por amalgamação com mercúrio, adição de bórax e queima do amalgamador.

Espectro de fluorescência de raios X

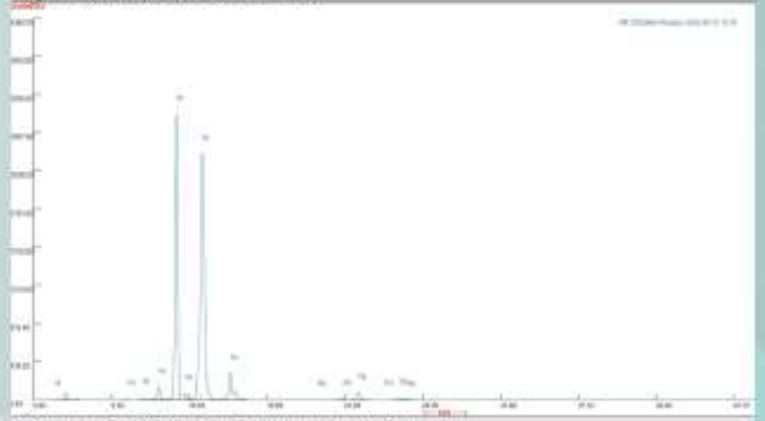
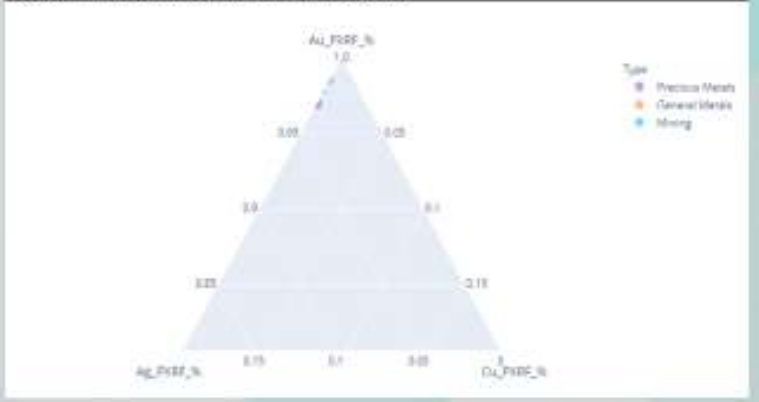
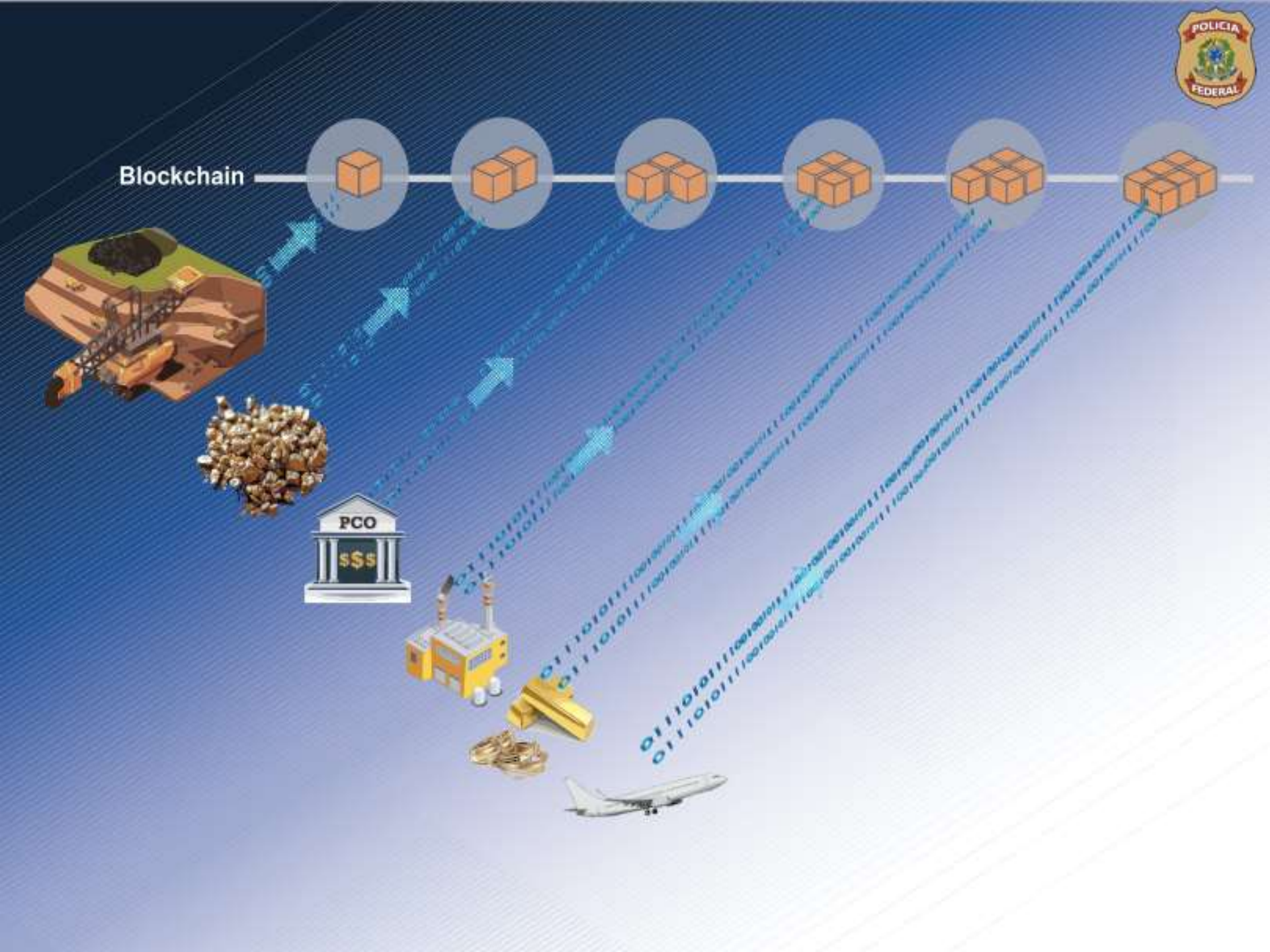


Diagrama de distribuição de ouro, prata e cobre




Blockchain
PCO
$$$
POLICIA
FEDERAL

Delphos Mining

Gold mining fraud module

Processo	CPF/CNPJ	Mês/Ano	Município	Média Mensal Municipal (g)	Nº Transações	Quantidade (g)	Quantidade Corrigida (g)
850397/2016	28277368000110	1/2021	ITAITUBA/PA	5900.34	1	416000.00	416000.00
850397/2016	28277368000110	3/2021	ITAITUBA/PA	260048.43	2	928930.00	928930.00
850397/2016	28277368000110	4/2021	ITAITUBA/PA	2668577.43	1	581002900.00	510247.53
850397/2016	28277368000110	5/2021	ITAITUBA/PA	34039.31	1	427300.00	427300.00
850397/2016	28277368000110	7/2021	ITAITUBA/PA	5173.55	1	442360.00	442360.00
850397/2016	28277368000110	8/2021	ITAITUBA/PA	5933.83	1	415450.00	415450.00

Exibindo 1 de 6 de 6 registros

International Seminar on Gold Traceability

Yanomami humanitarian crisis

Contents lists available at ScienceDirect

The Extractive Industries and Society

journal homepage: www.elsevier.com/locate/exis

Original Article

Challenges with resolving mining conflicts in Latin America☆

Ann Helwege

CNN World

Amanda Perobelli/Reuters

A Yanomami child, who is being treated for malnutrition, sits with his father in Boa Vista, Roraima state, on January 27. Disease and malnutrition have torn through Yanomami villages over the last four years.

The Yanomami people lived in harmony with nature. Invaders turned their lives into a fight for survival.

By Tara John and Rodrigo Pedroso, CNN

Updated 12:36 PM EST, Sun February 12, 2023

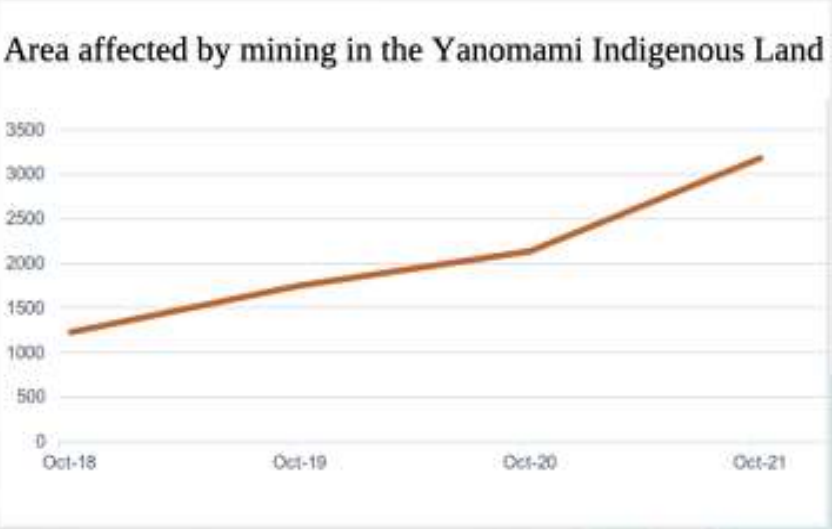
New York (CNN) — Shaman Davi Kopenawa Yanomami

REUTERS® World Business Markets Legal Breakingviews Technology Investigations

Dozens of Yanomami children hospitalized in northern Brazil amid health crisis

By Leonardo Benassatto and Amanda Perobelli

Context

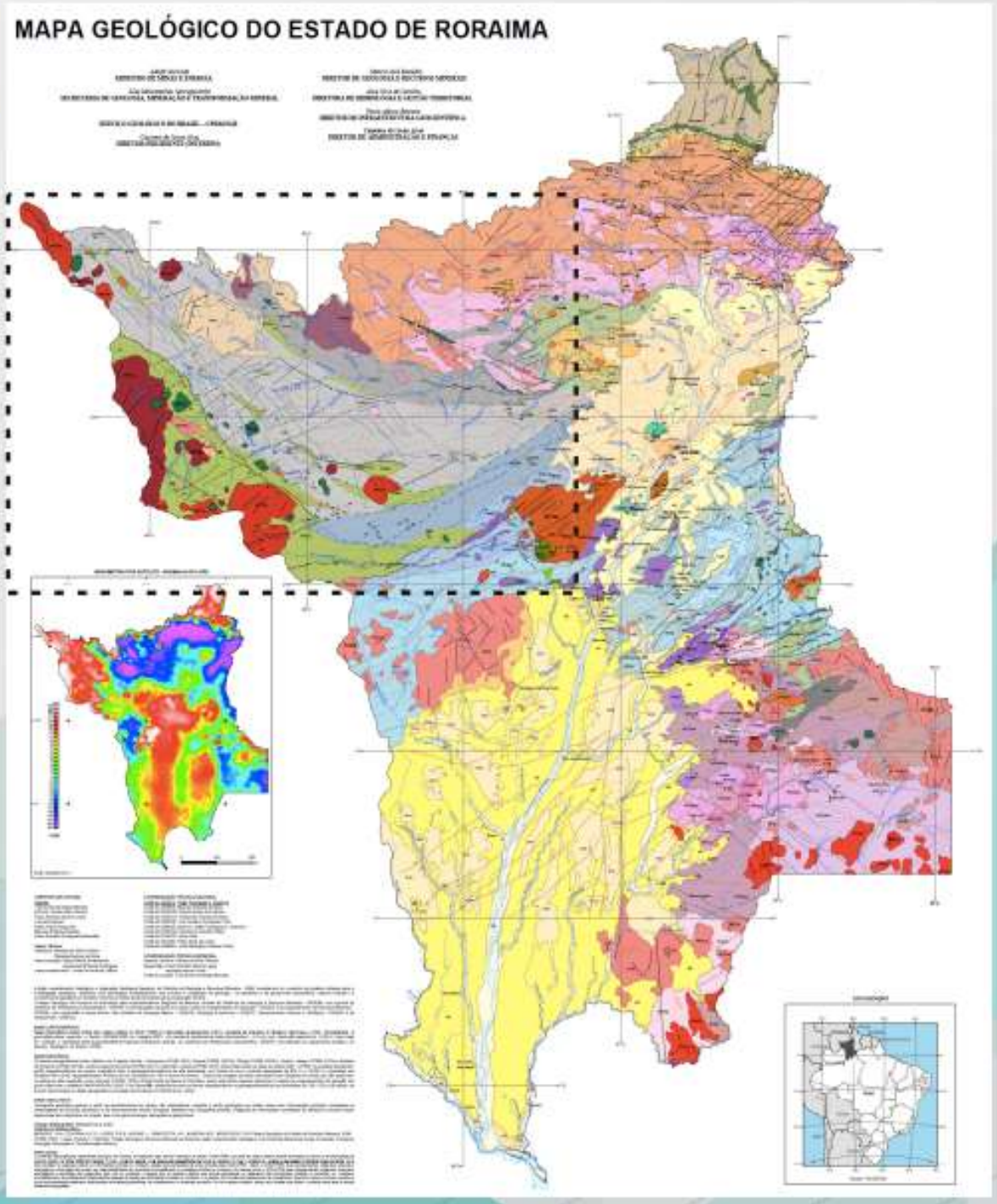


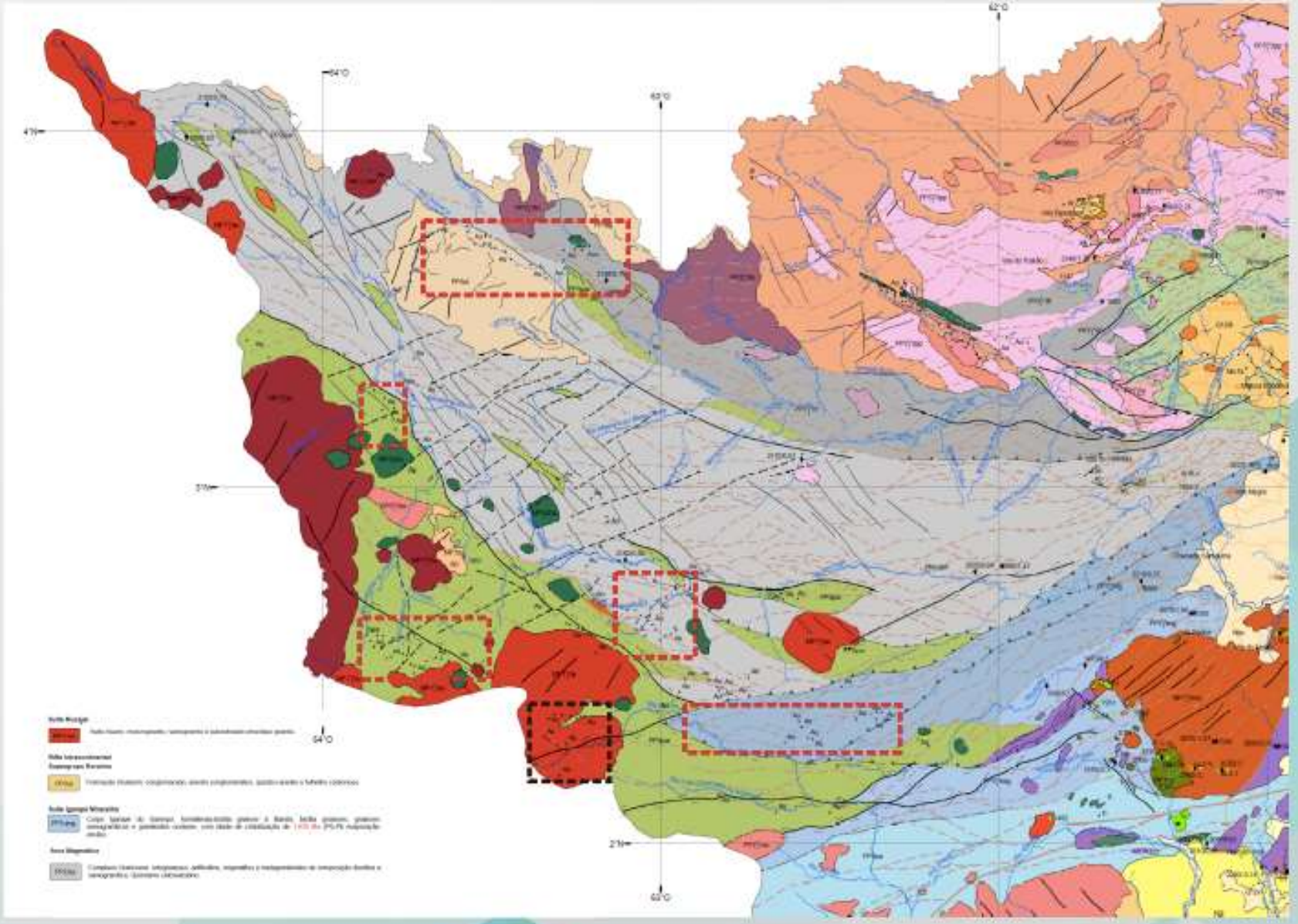
REGION	DEC/22	DEC/21	Annual Increme	Annual variation
Alto Catrimani	104.36	175.43	71.069	68%
Alto Mucajaí	15.75	17.11	1.36	9%
Apiaú	76.79	106.65	29.859	39%
Auaris	0	4.05	4.05	
Demini	2.32	1.86	-0.46	-20%
Ericó	19.04	23.36	4.324	23%
Hakoma	24.98	42.21	17.23	69%
Homoxi	145.98	399.29	253.31	174%
Kayanau	510.17	688.81	178.64	35%
Médio Catrimani	12.8	4.36	-8.44	-66%
Palimiu	4.76	15.59	10.83	228%
Papiu	17.44	38.77	21.33	122%
Parafuri	0	5.51	5.51	
Parima (Arathau)	77.76	112.32	34.56	44%
Surucucus	35.18	27.49	-7.69	-22%
Uraricoera	5.4	2.98	-2.42	-45%
Waputha	0	4.01	4.01	
Waikás	1169.93	1466.11	296.18	25%
Xitei	11.34	136.18	124.84	1101%
TOTAL	2234	3272.09	1038.092	46%

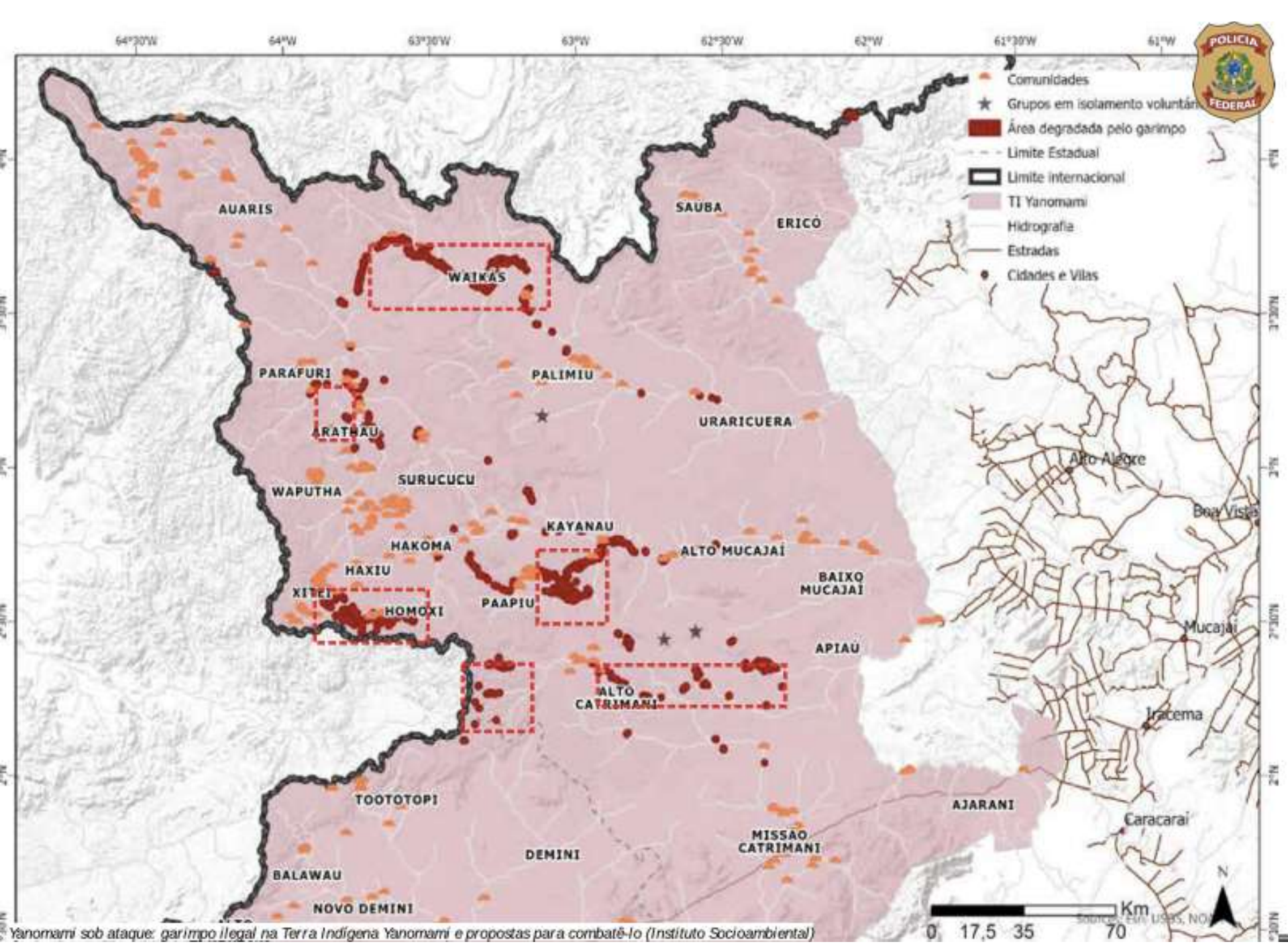
Area (hectares)

Yanomami sob ataque: garimpo ilegal na Terra Indígena Yanomami e propostas para combatê-lo (Instituto Socioambiental)

Geology




64°O
63°O
62°O
4°S
5°S
6°S
7°S



Yanomami sob ataque: garimpo ilegal na Terra Indígena Yanomami e propostas para combatê-lo (Instituto Socioambiental)

Uraricuera river (Instituto Socioambiental)

Urariquera (Instituto Socioambiental)

Waikás

Parima River (Instituto Socioambiental)

Xitei

Xitei (Instituto Socioambiental)

Xitei (Instituto Socioambiental)

Homoxi

Homoxi (Instituto Socioambiental)

Catrimani

Samples

Cooperation Agreements

SGB GEOLOGICAL SURVEY OF BRAZIL - CPRM

IBRAM
MINERAÇÃO DO BRASIL

ANM Agência Nacional de Mineração

Thank you

M. Sc. **ERICH** ADAM MOREIRA LIMA
Perito Criminal Federal
Federal Forensics Expert

+ 55 63 99265-5005
erich.eaml@pf.gov.br
linkedin.com/in/erich-adam-9413a248
Chefe do Setor de Perícias em Geologia | *Head of Forensic Geology Sector*
Instituto Nacional de Criminalística, Brasília/DF - Brasil | *National Institute of Criminalistics*