

# Zoneamento Agrogeológico do Brasil

## Escala 1:1.000.000

Brasília, Brasil  
Nov  
2018

MINISTÉRIO DA  
AGRICULTURA, PECUÁRIA  
E ABASTECIMENTO



MINISTÉRIO DE  
MINAS E ENERGIA





# Tópicos

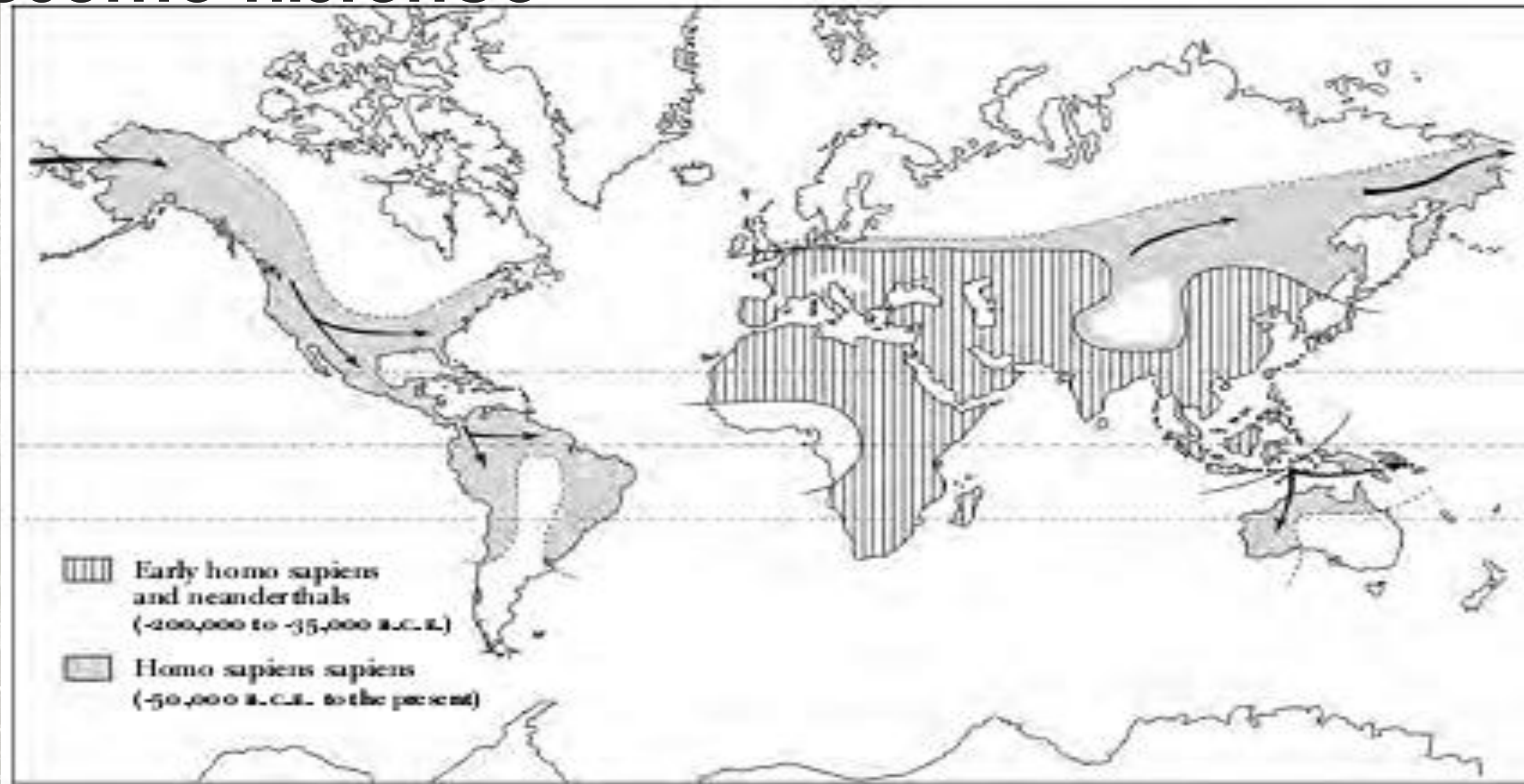
- Introdução: Centros de Origem, Agromineral, Agrogeologia, Zoneamento Agrogeológico, Dependência Externa, Eficiência de Uso de Nutrientes
- Objetivos: ZAG para planejamento do manejo de recursos regionais
- Abordagem metodológica: Ocorrência e consumo de agrominerais  
Zonas de ocorrência potencial de agrominerais (ZP)  
Zonas de consumo de agrominerais (ZC)
- Zoneamento Agrogeológico (ZAG): Avaliação de cada agromineral  
Avaliação integrada entre ocorrência e consumo de agrominerais
- Conclusões: Abundância de agrominerais regionais



# Prelúdio



# Resumo histórico



Mazoyer e Roudart (2006) A History of World Agriculture



# Agricultura

Aquecimento  
climático

Hoje

Anos atrás 12,000 10,000 4,500 2,000 1,500 1,000 500 300 200 120 60 30 20 +30

Coletores e caçadores

Revolução  
Agrícola

Slash and Burn

Agricultura hidráulica

Revolução Verde

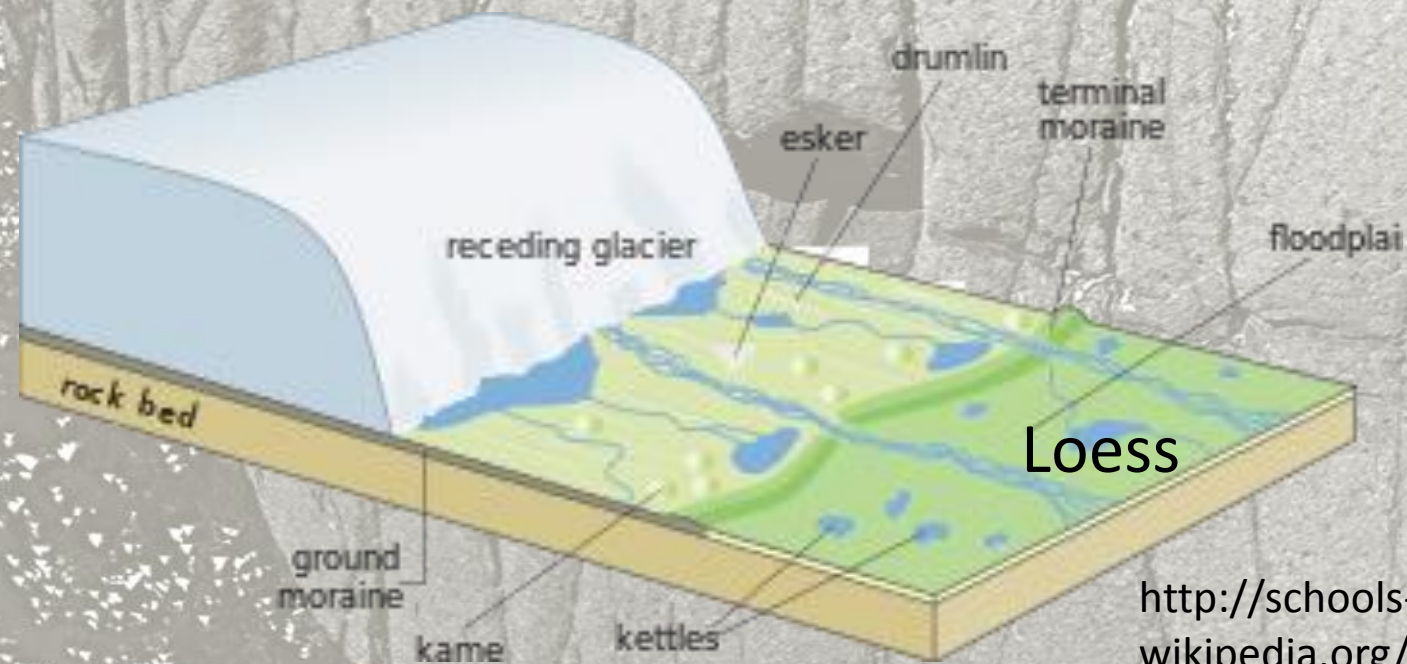
Revolução Sempre-Verde



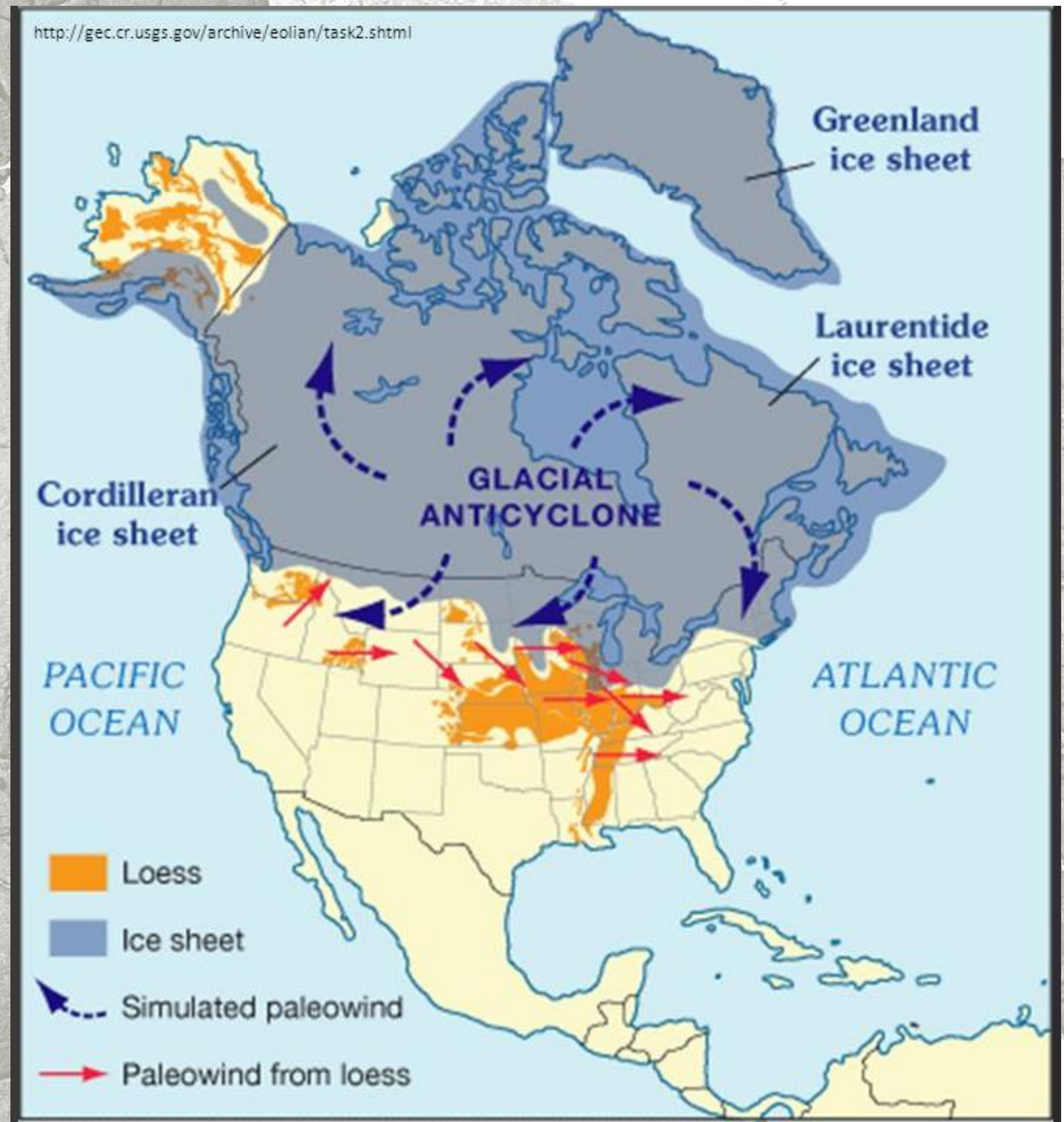
# O maior moinho da Terra!



<http://glacialfeatures.weebly.com/uploads/5/8/1/2/58120967/220595532.jpg>

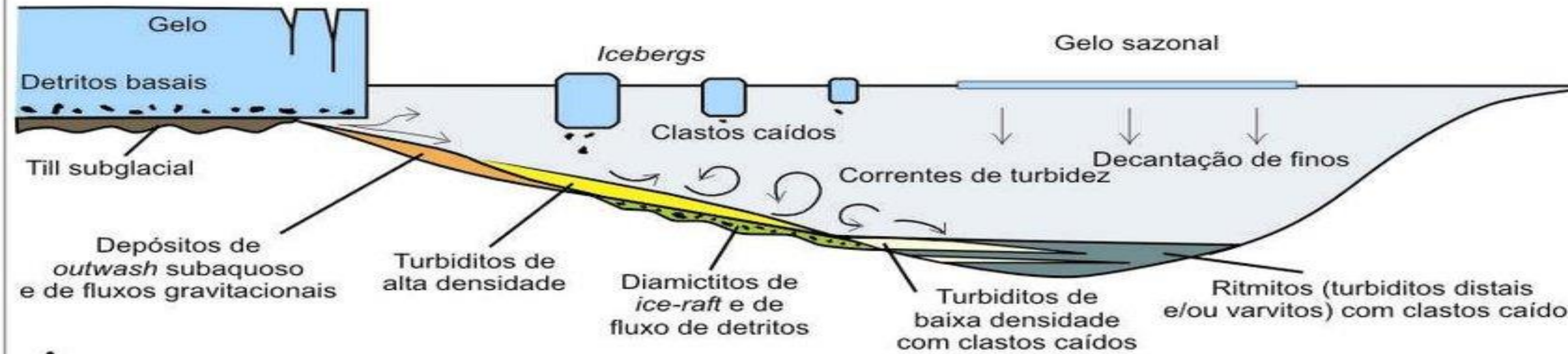


<http://schools-wikipedia.org/images/2760/276096.png>



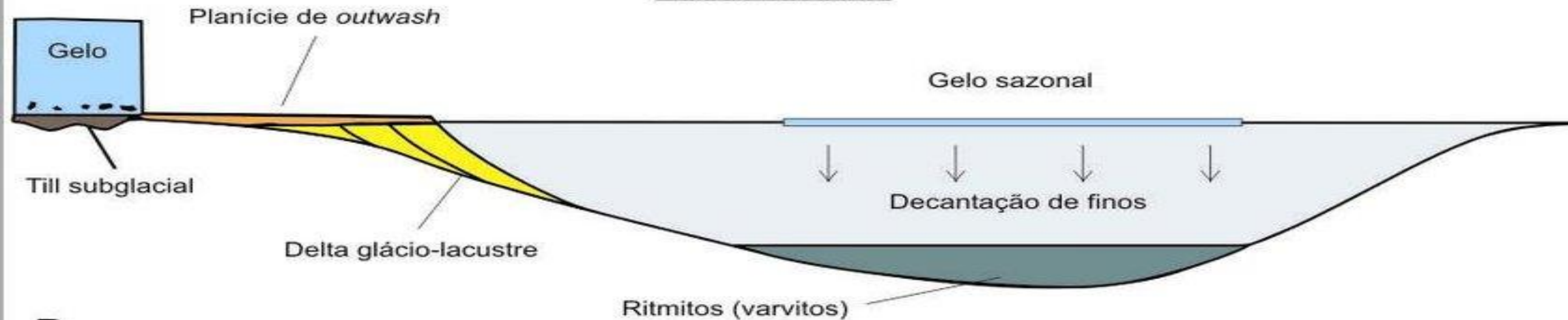


## LAGO EM CONTATO COM O GELO



A

## LAGO DISTAL



B

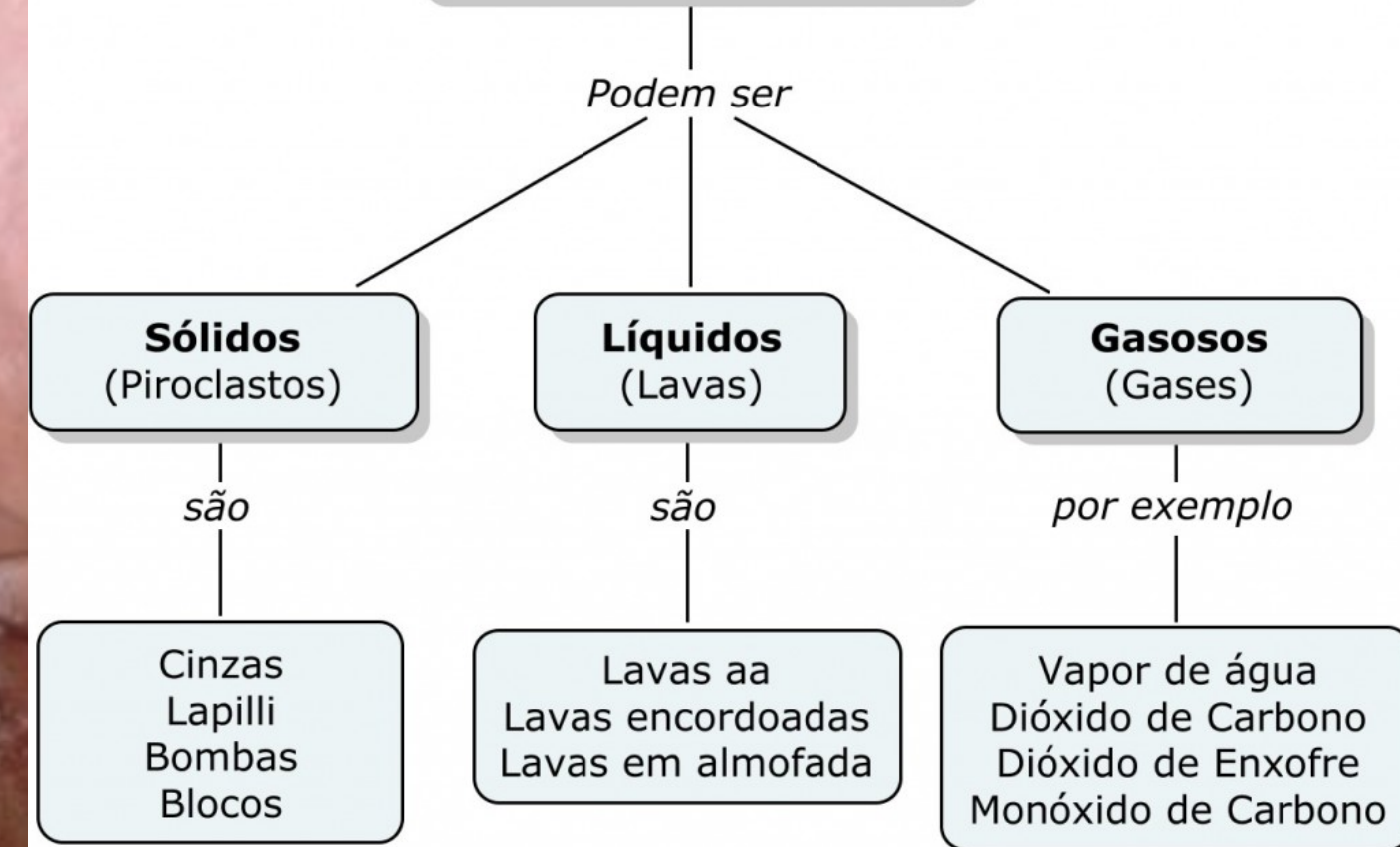


# Vulcões e cinzas



<http://espacociencias.com.pt/site/wp-content/uploads/2012/11/cinza-usgs.jpg>

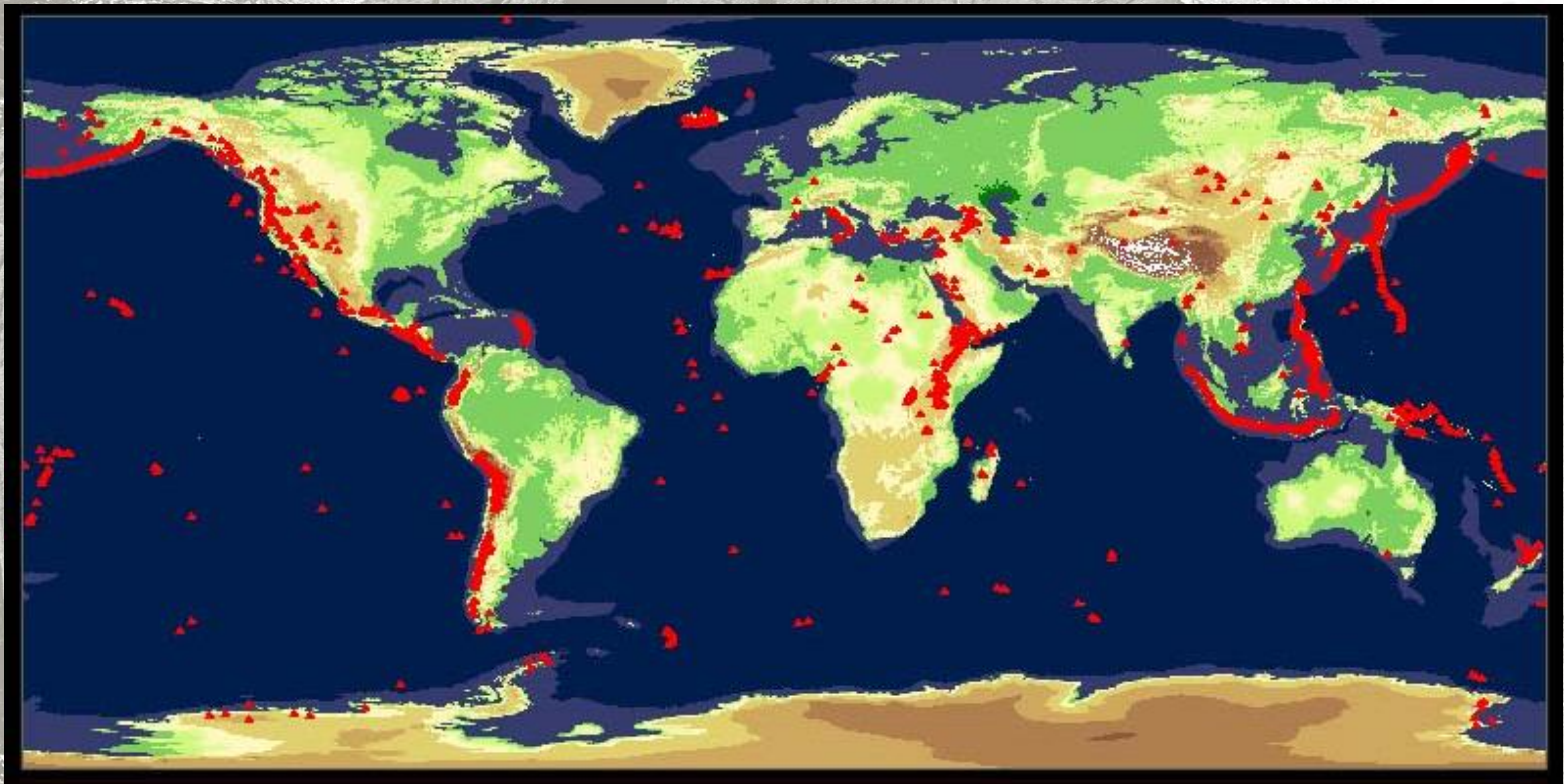
## MATERIAIS EXPELIDOS PELOS VULCÕES



<http://espacociencias.com.pt/site/wp-content/uploads/2012/11/Materiais-vulc%C3%B5es-1024x731.jpg>



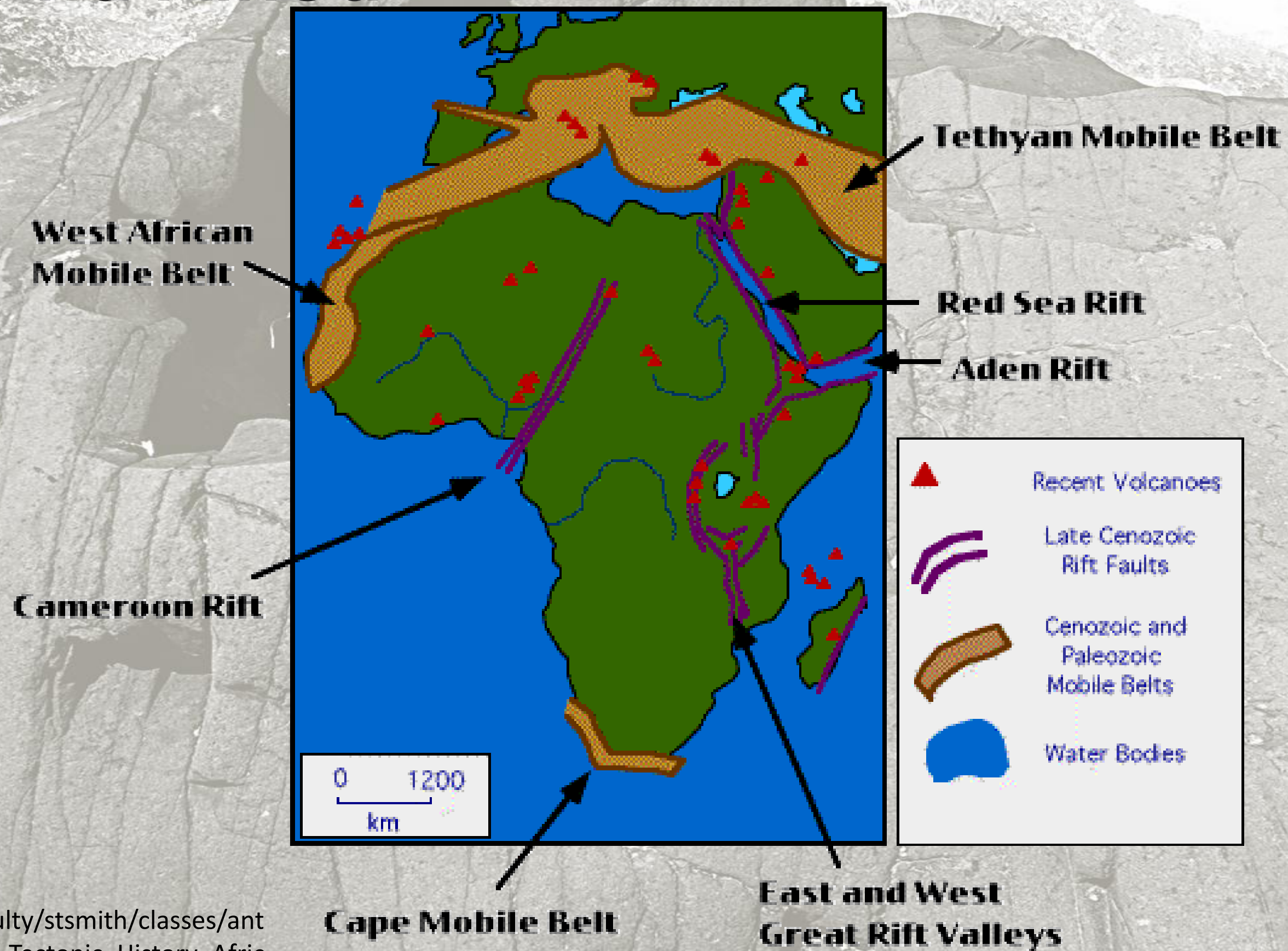
# Vulcões no mundo



[https://vignette.wikia.nocookie.net/hypotheticalvolcanoes/images/5/58/World\\_Volcano\\_Map.jpg/  
revision/latest?cb=20141123042945](https://vignette.wikia.nocookie.net/hypotheticalvolcanoes/images/5/58/World_Volcano_Map.jpg/revision/latest?cb=20141123042945)

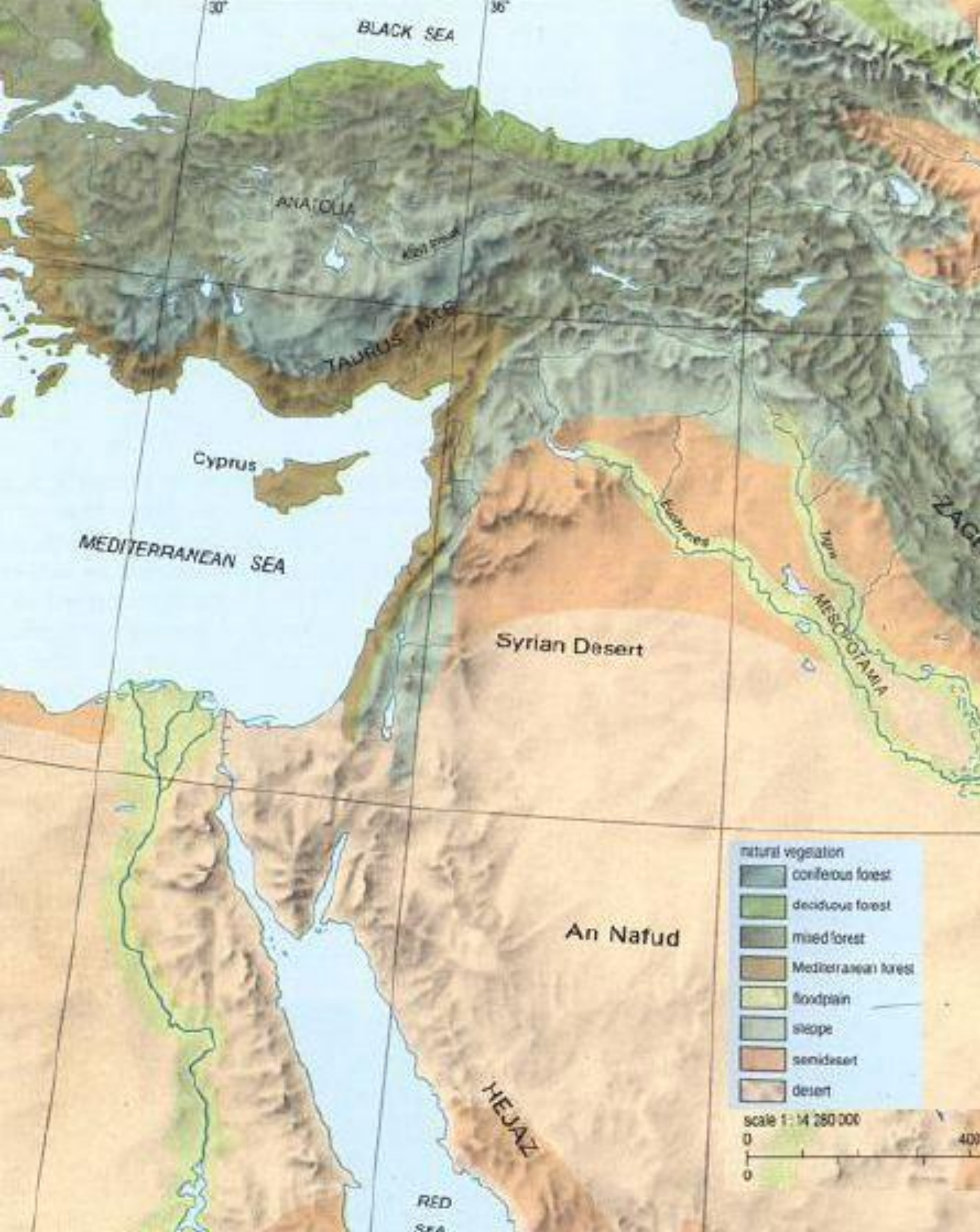


# Vulcões na África



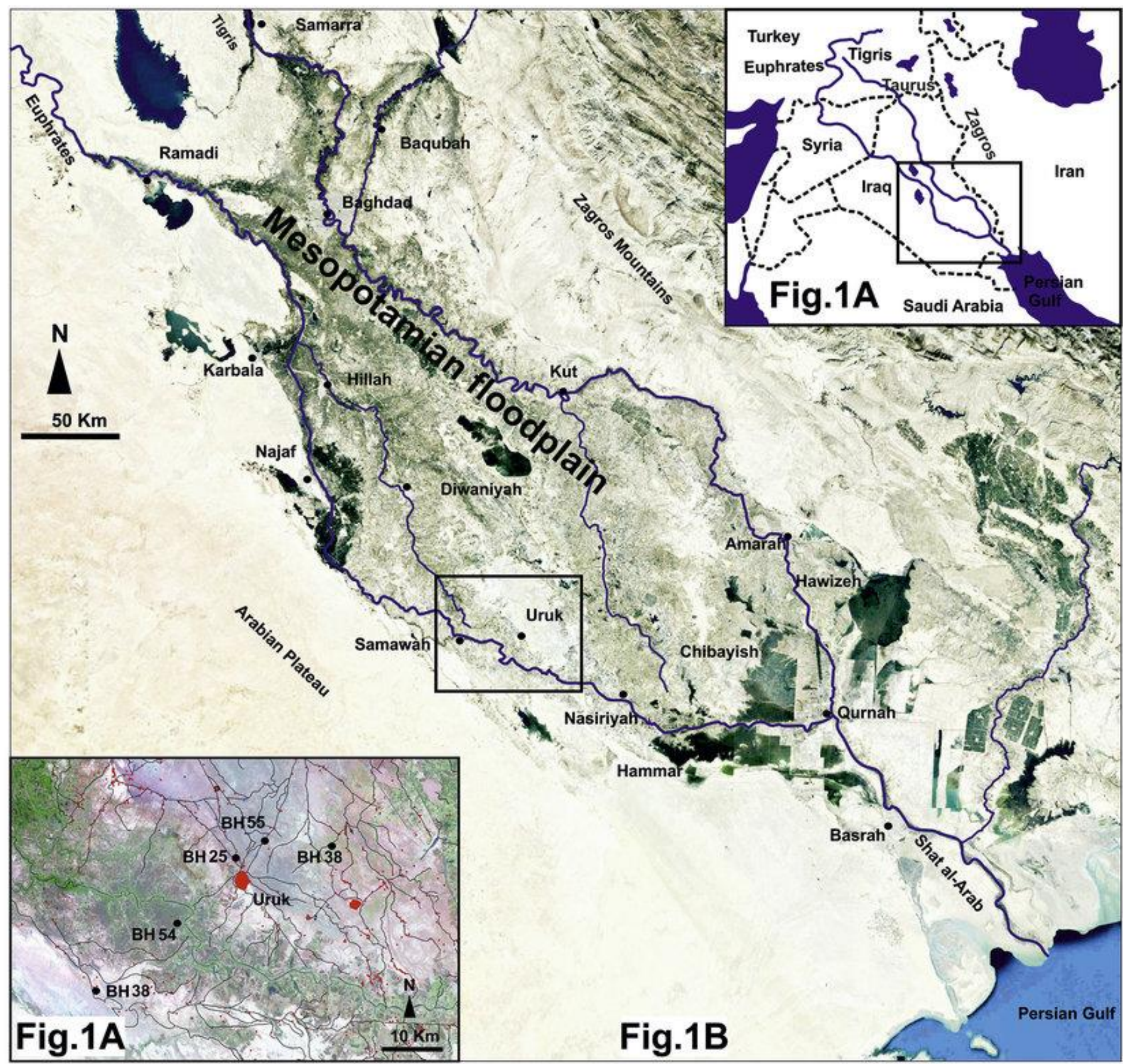
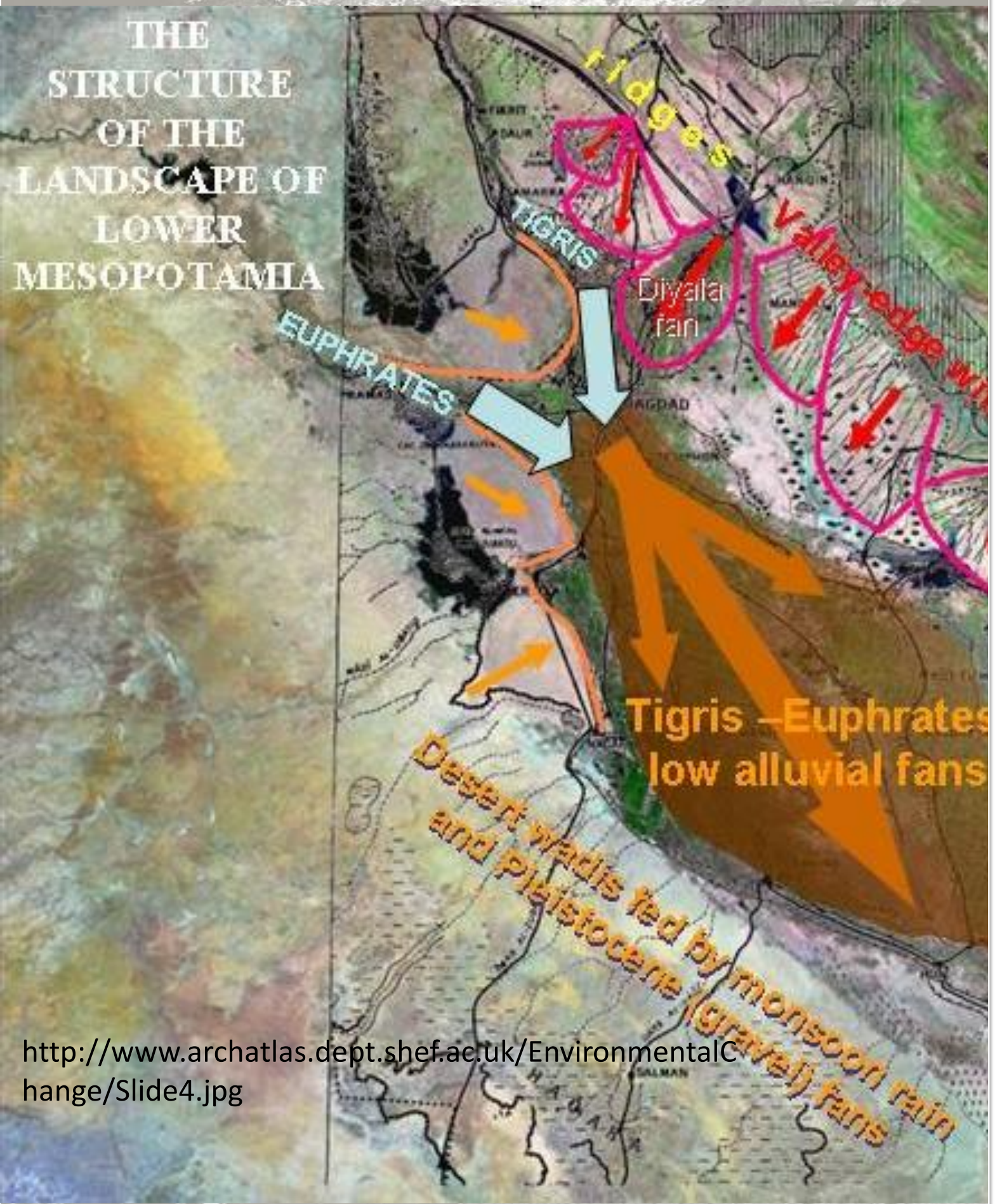
[http://www.anth.ucsb.edu/faculty/stsmith/classes/anth3/courseware/OlduvaiForm/3\\_Tectonic\\_History\\_Africa.html](http://www.anth.ucsb.edu/faculty/stsmith/classes/anth3/courseware/OlduvaiForm/3_Tectonic_History_Africa.html)







# Grandes planícies fluviais



<http://www.archatlas.dept.shef.ac.uk/EnvironmentalChange/Slide4.jpg>

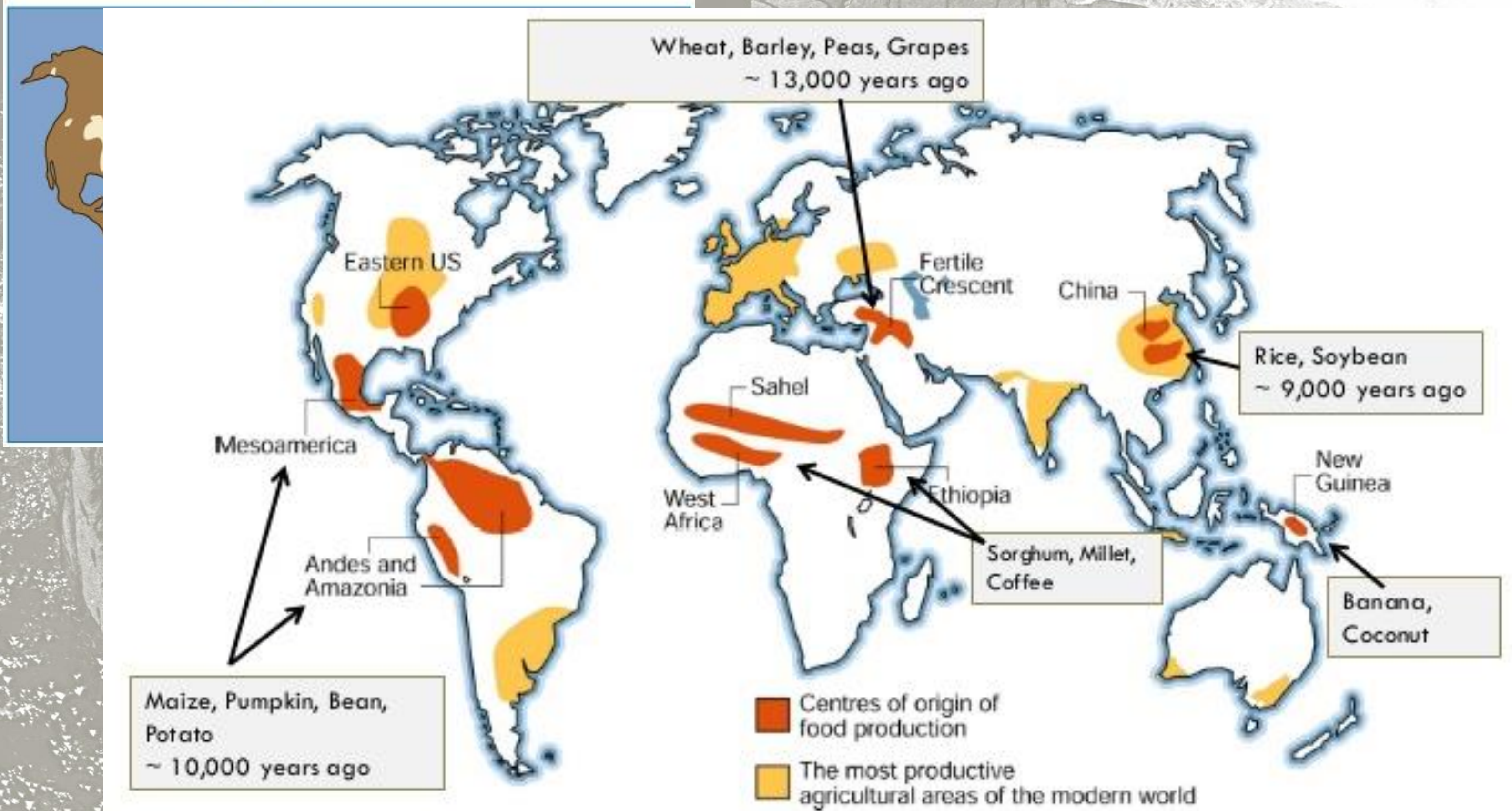




Egito antigo

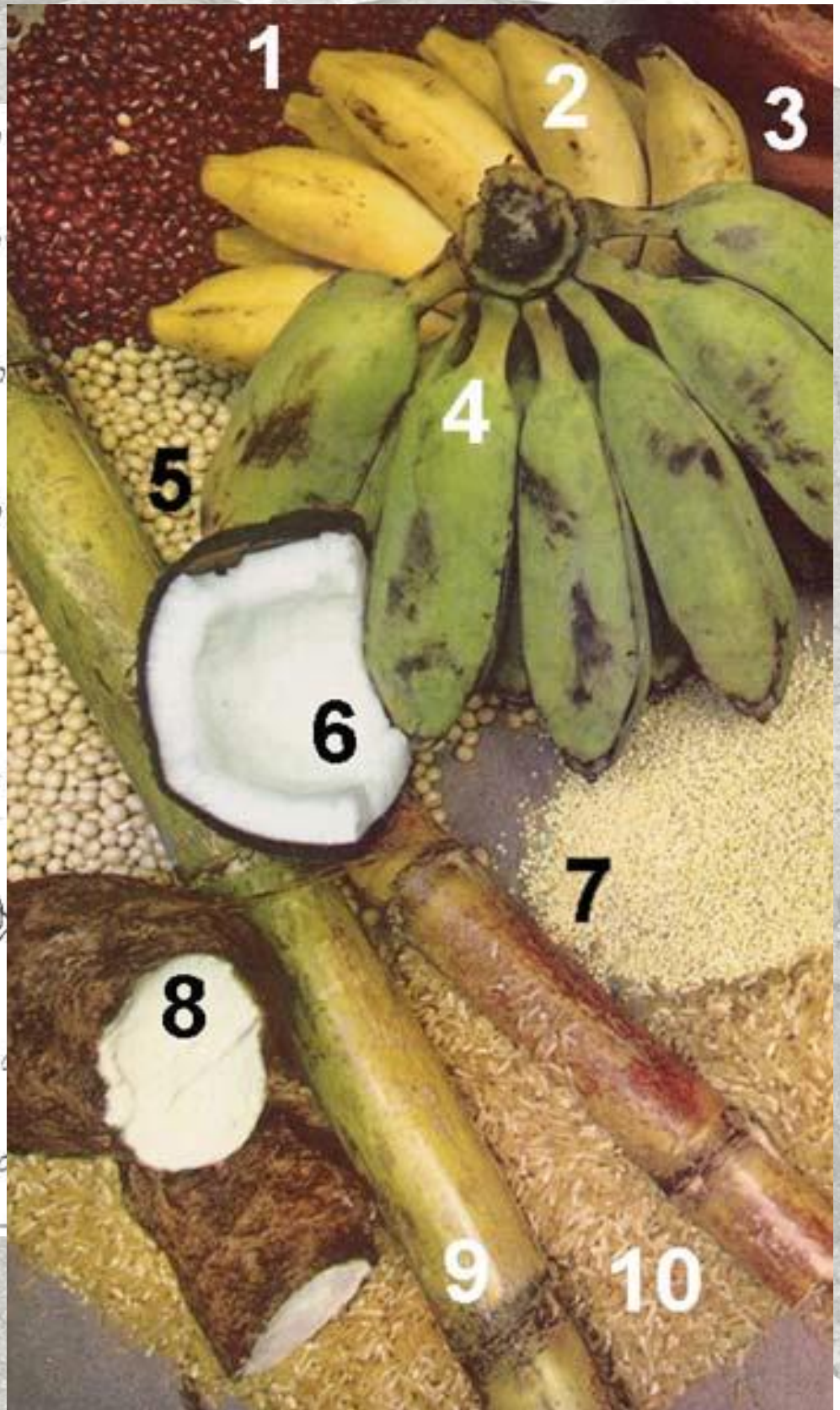
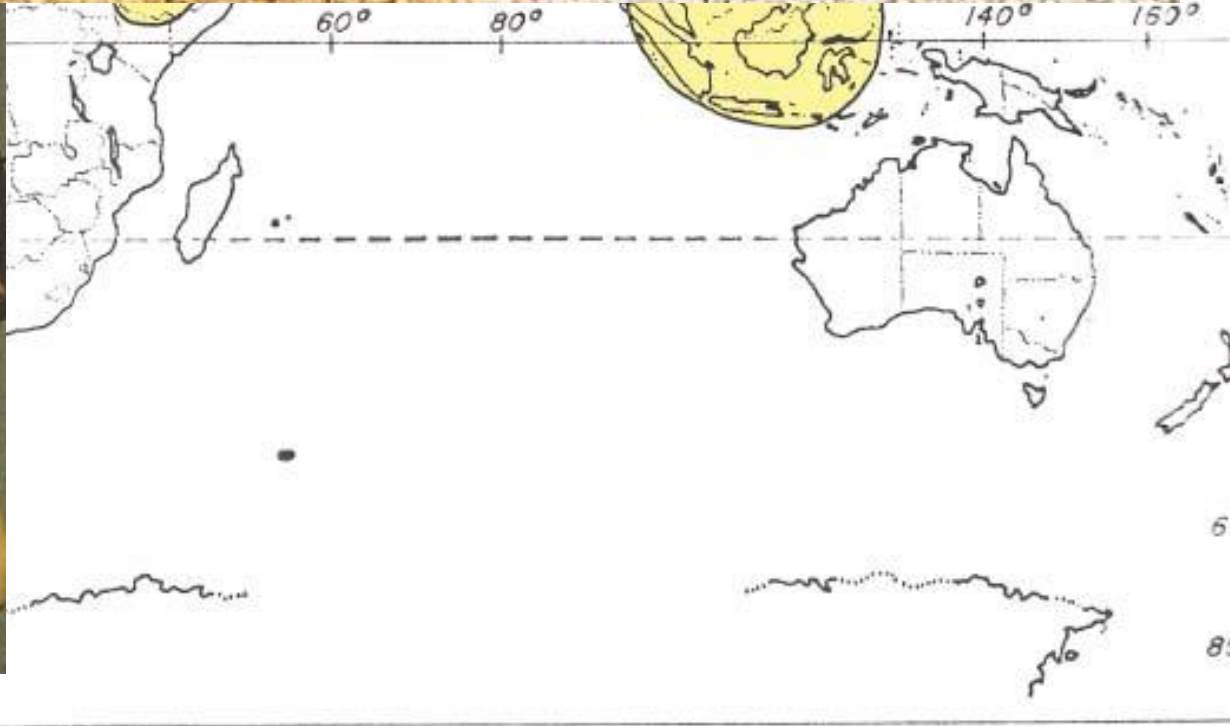


# Centros de origem de plantas e relação com silicatos





# Centros de Origem e relação com silicatos

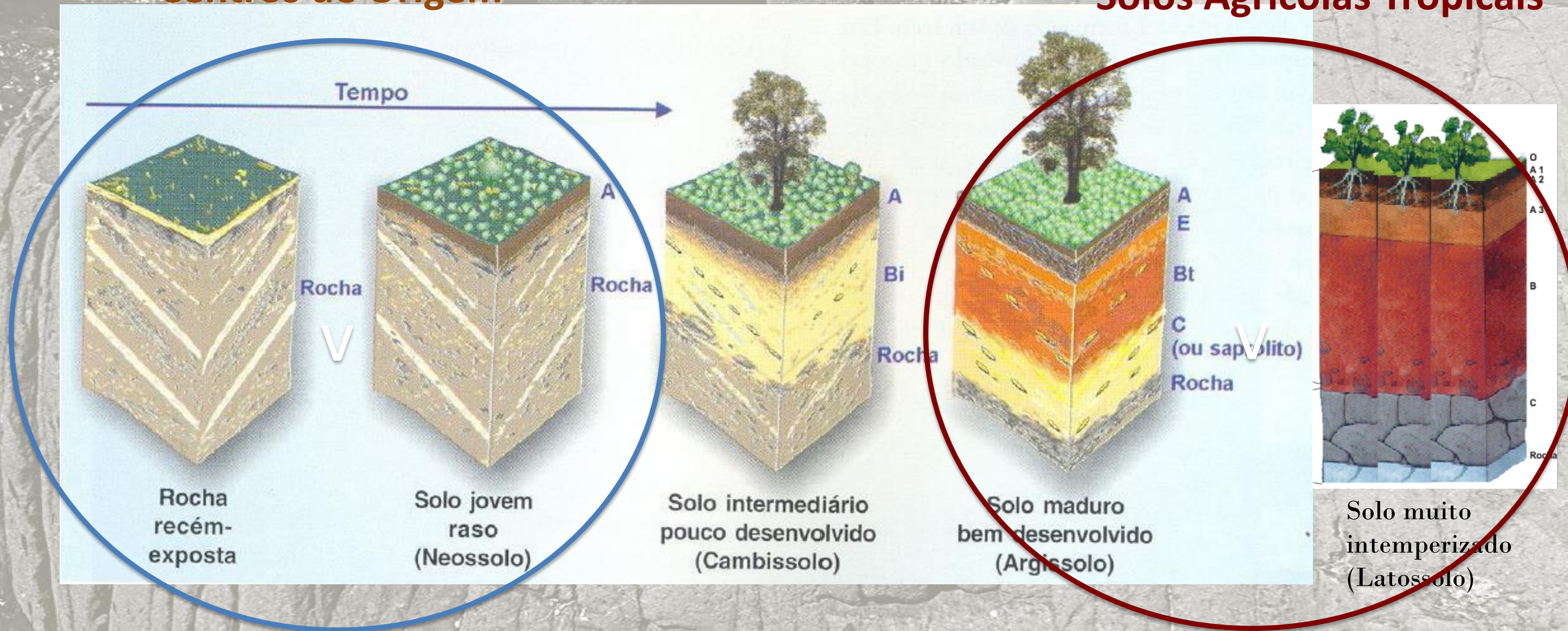




# Centros de Origem e Solos Tropicais

## Centros de Origem

## Solos Agrícolas Tropicais



**Minerais primários**

Origem Si, Ca, Mg, K

**Argilominerais 2:1**

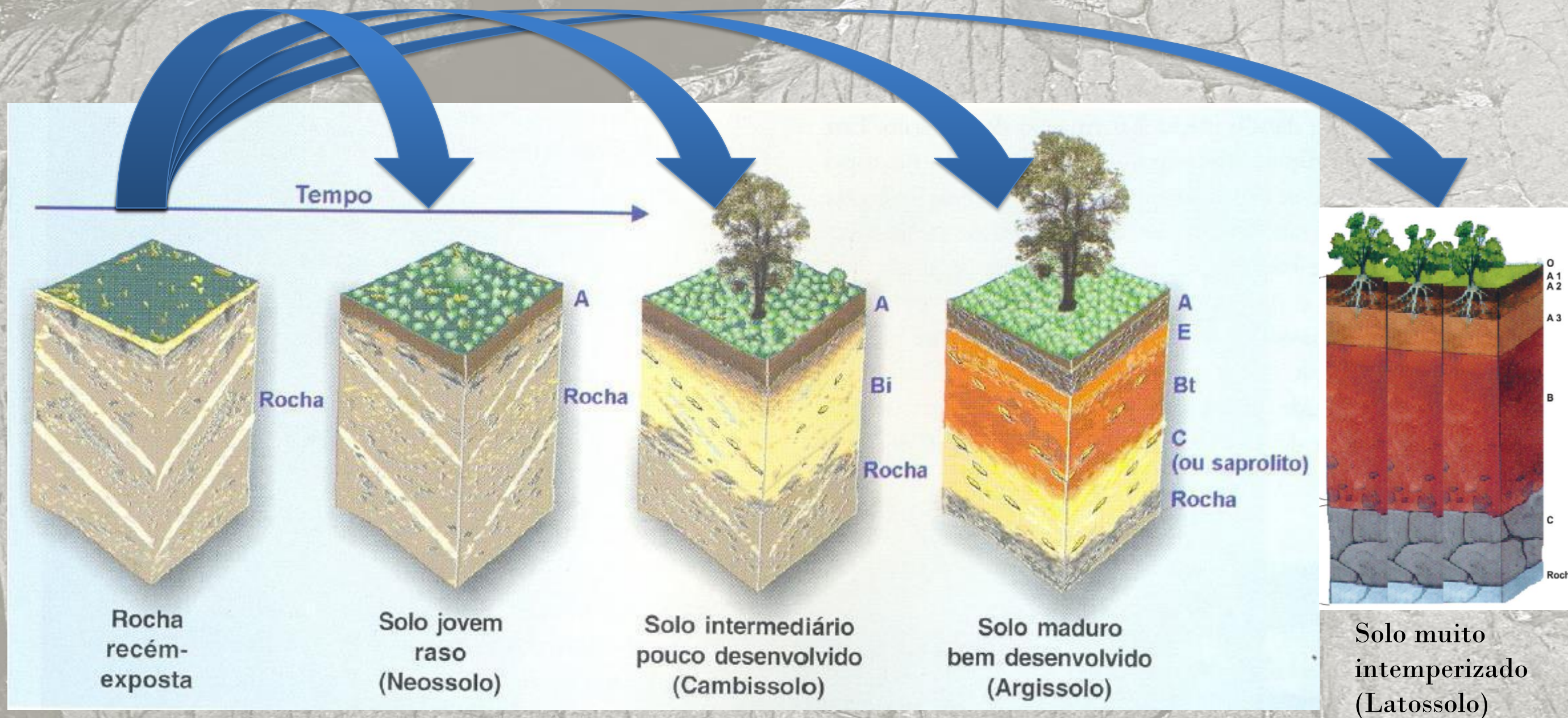
Manutenção parcial do Si, Ca, Mg, K  
Minerais expansivos, retenção de água,  
Retenção de cátions

**Óxidos de ferro e de alumínio**

Perda total do Si, Ca, Mg, K  
Minerais não expansivos,  
Baixa retenção de água e cátions  
Retenção de ânions



# Remineralização de Solos





# Deposição de cinza vulcânica Monte Merapi, Indonésia (2010)



## Moagem natural

**Erupção vulcânica, movimento de glaciares, erosão de rochas**



## Transporte natural

**Glacial, eólica, fluvial**



## Deposição natural

**Sedimentação glacial, eólica, fluvial**



# Processo de remineralização de solos



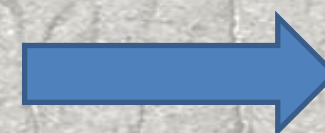
**Moagem antrópica**

**Explosão e britagem**



**Transporte antrópico**

**Rodoviário e ferroviário**



**Deposição antrópica**

**A lança mecanizada**



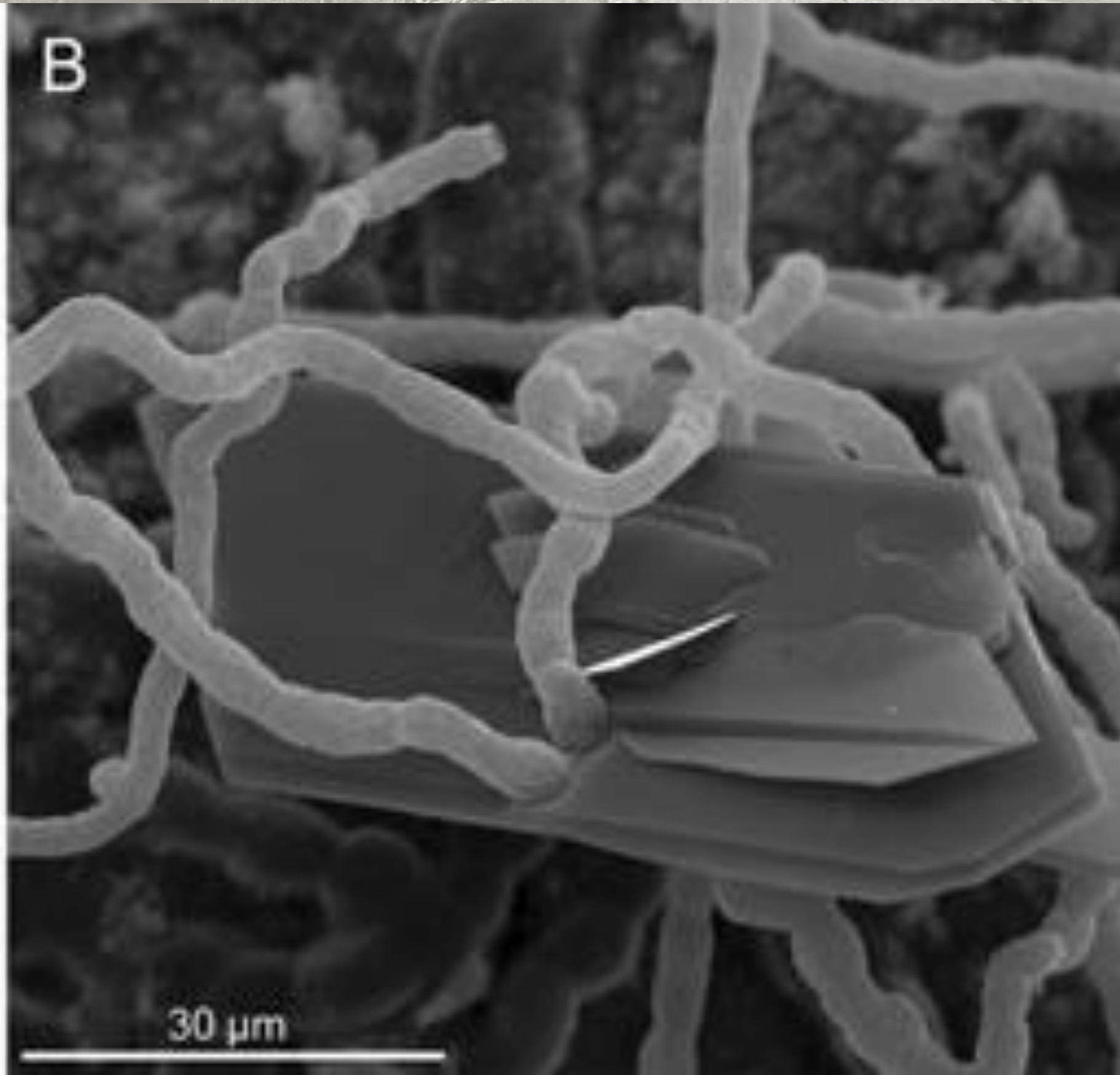
# Biointemperismo





# Biointemperismo

**Fonte:** Bonneville et al (2011)  
Tree-mycorrhiza Symbiosis  
accelerate mineral weathering.  
*Geoch. Cosmoch. Acta*, 75:6988-  
7005





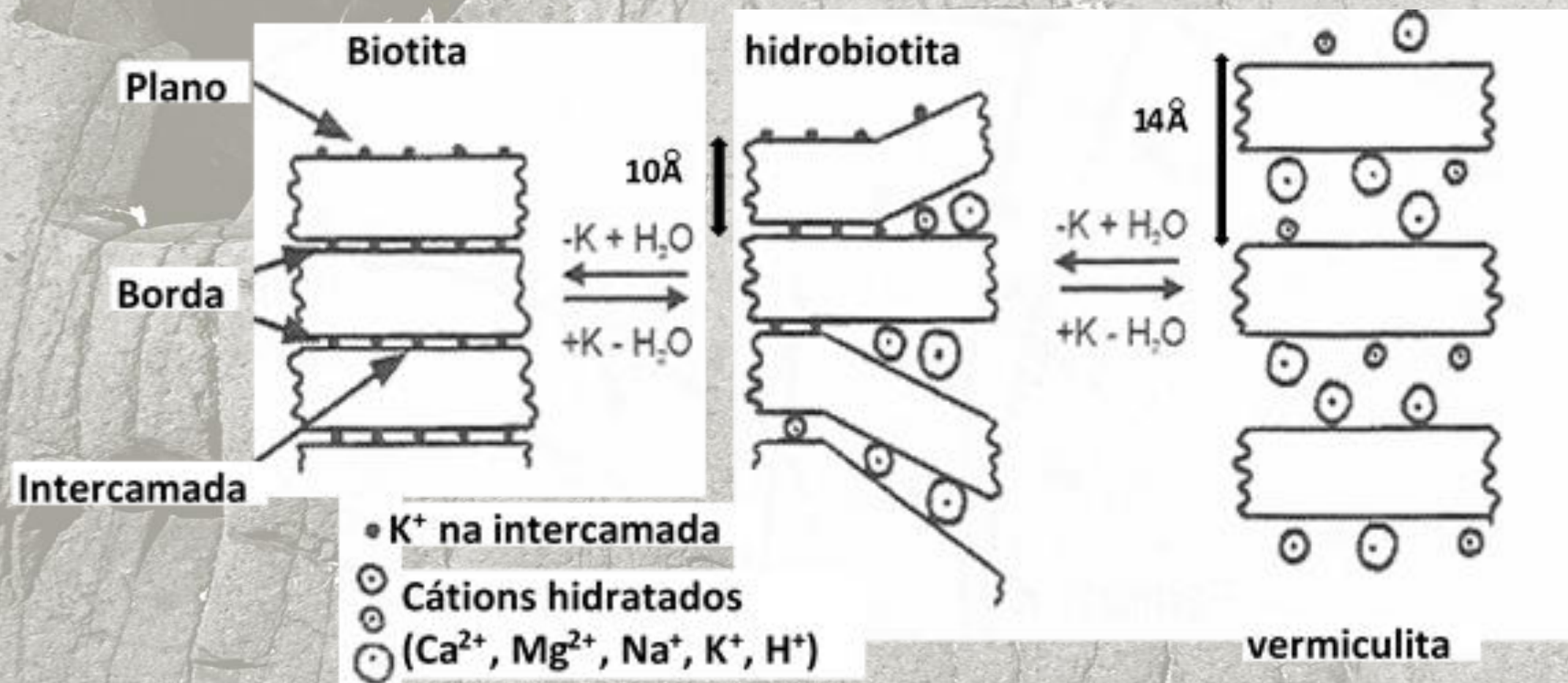
# Biointemperismo

Biotita



Vermiculita

+ K +Si +Mg +Fe



Fonte: Van Straaten (2007)

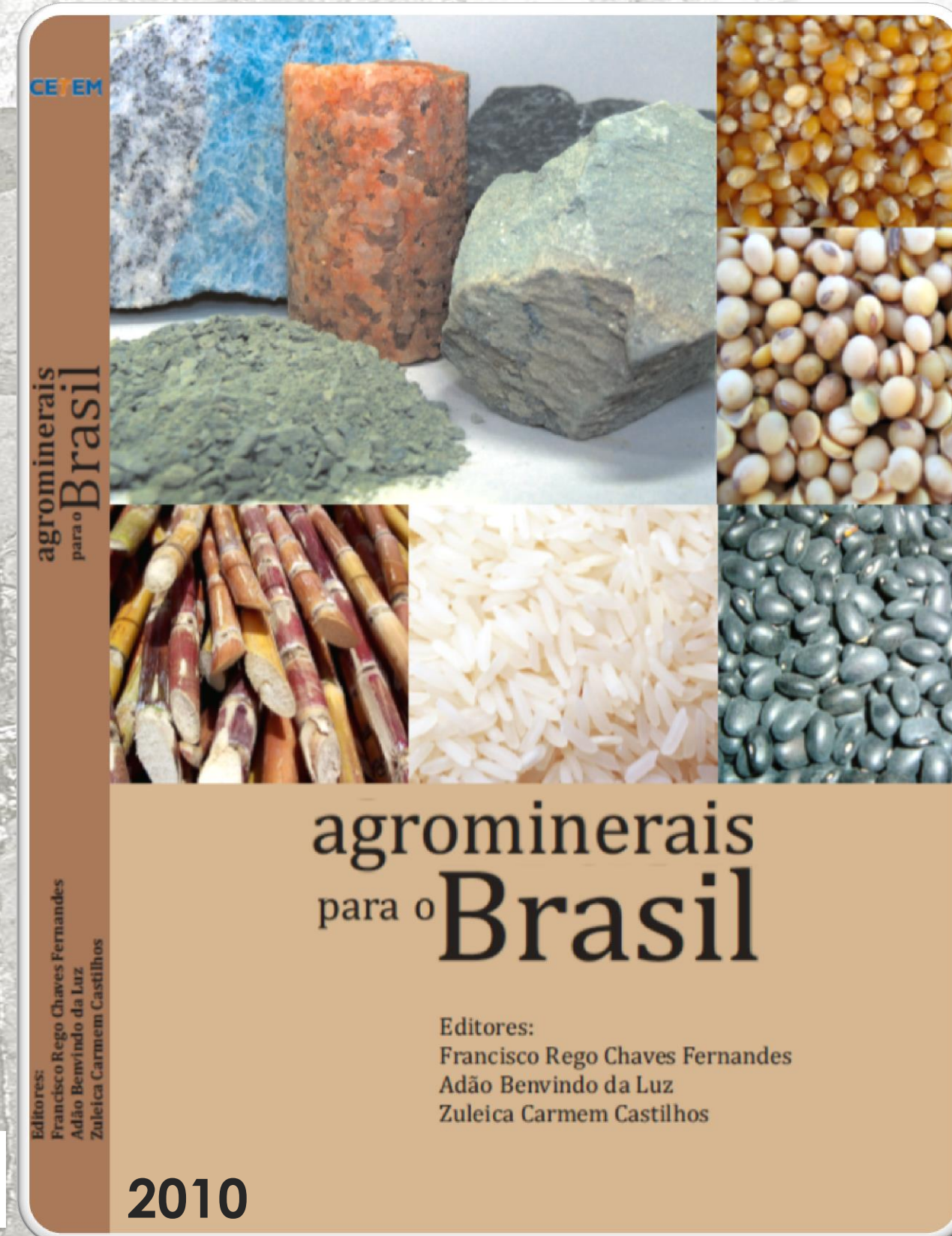


# Agrominerais



# Agromineral

Matéria prima mineral para a produção de insumos destinados ao manejo da fertilidade do solo





# Tipos de Agrominerais

Classe de ânion		Tipo de rochas*	Cátions principais	Cobertura da crosta (% área) <sup>10</sup>	Solubilidade em água
<b>Carbonato</b>	CO <sub>3</sub> <sup>2-</sup>	Calcário (sedimentar) <sup>1</sup> Carbonatito (ígneo) <sup>2</sup> Mármore (metamórfico) <sup>3</sup>	Ca <sup>2+</sup> , Mg <sup>2+</sup>	10,0	Baixa
<b>Sulfato</b>	SO <sub>4</sub> <sup>2-</sup>	Depósitos evaporíticos (sedimentar) <sup>4</sup>	Ca <sup>2+</sup> (Mg <sup>2+</sup> , K <sup>+</sup> )	0,0	Muito alta
<b>Cloreto</b>	Cl <sup>-1</sup>	Depósitos evaporíticos (sedimentar)	K <sup>+</sup>	0,0	Muito alta
<b>Fosfato</b>	PO <sub>4</sub> <sup>3-</sup>	Fosforito (sedimentar) <sup>5</sup> Foscorito (ígneo) <sup>6</sup>	Ca <sup>2+</sup>	0,0	Baixa
<b>Silicato</b>	SiO <sub>4</sub> <sup>4-</sup>	Sedimentar <sup>7</sup> Ígneo <sup>8</sup> Metamórfico <sup>9</sup>	Ca <sup>2+</sup> , Mg <sup>2+</sup> , K <sup>+</sup>	90,0	Muito baixa

\*Exemplos de pesquisa com agrominerais *in natura*: <sup>1</sup>Sousa et al. (1989); <sup>2</sup>Andrade et al. (2002); <sup>3</sup>Raymundo et al. (2013); <sup>4</sup>Freire et al. (2014); <sup>5</sup>Chaves et al. (2013); <sup>6</sup>Resende et al. (2006); <sup>7</sup>Lopes (1971); <sup>8</sup>Mancuso et al. (2014); <sup>9</sup>Duarte et al. (2012).  
<sup>10</sup>Scoffin (1987).



# Agrogeologia

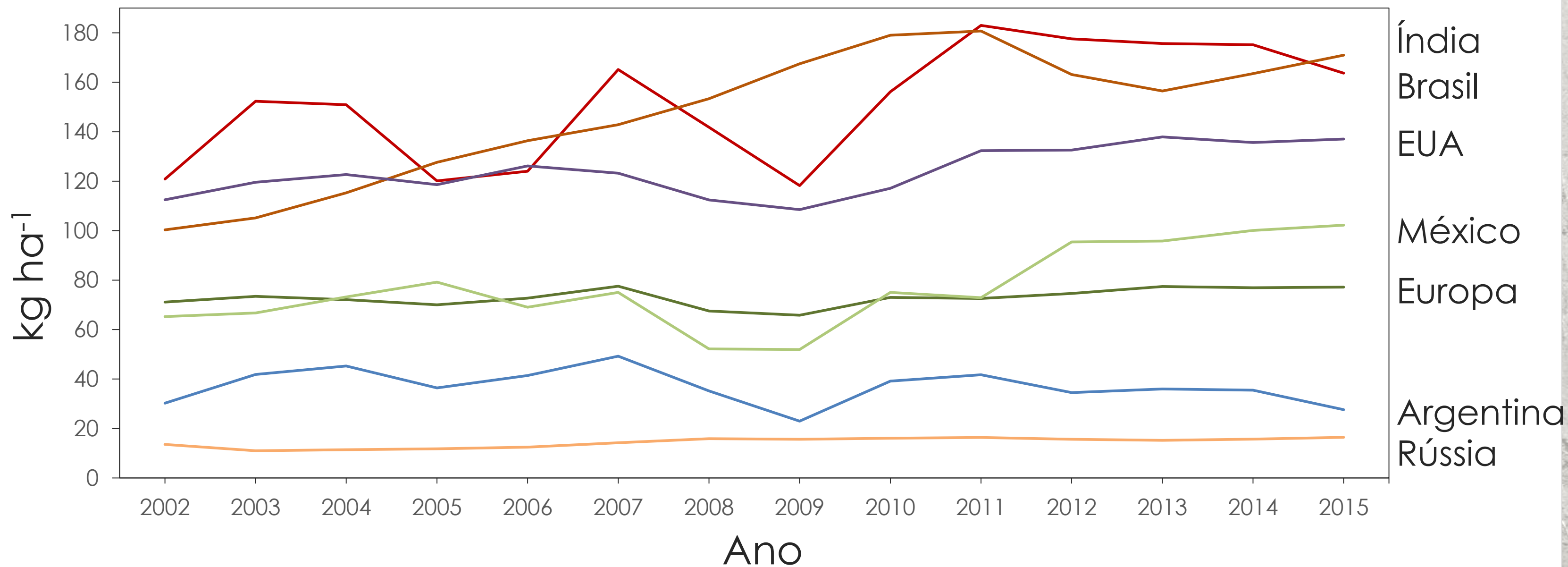
**Ciência que estuda processos geológicos que influenciam a distribuição e formação dos solos, bem como a aplicação de materiais geológicos em sistemas agrícolas e florestais como forma de manter e melhorar a produtividade do solo para o aumento dos benefícios sociais, econômicos e ambientais.**

**(Chesworth e Van Straaten, 1993)**



# Consumo de nutrientes

## Países com taxas de consumo de NPK inferiores a 180 kg ha<sup>-1</sup>

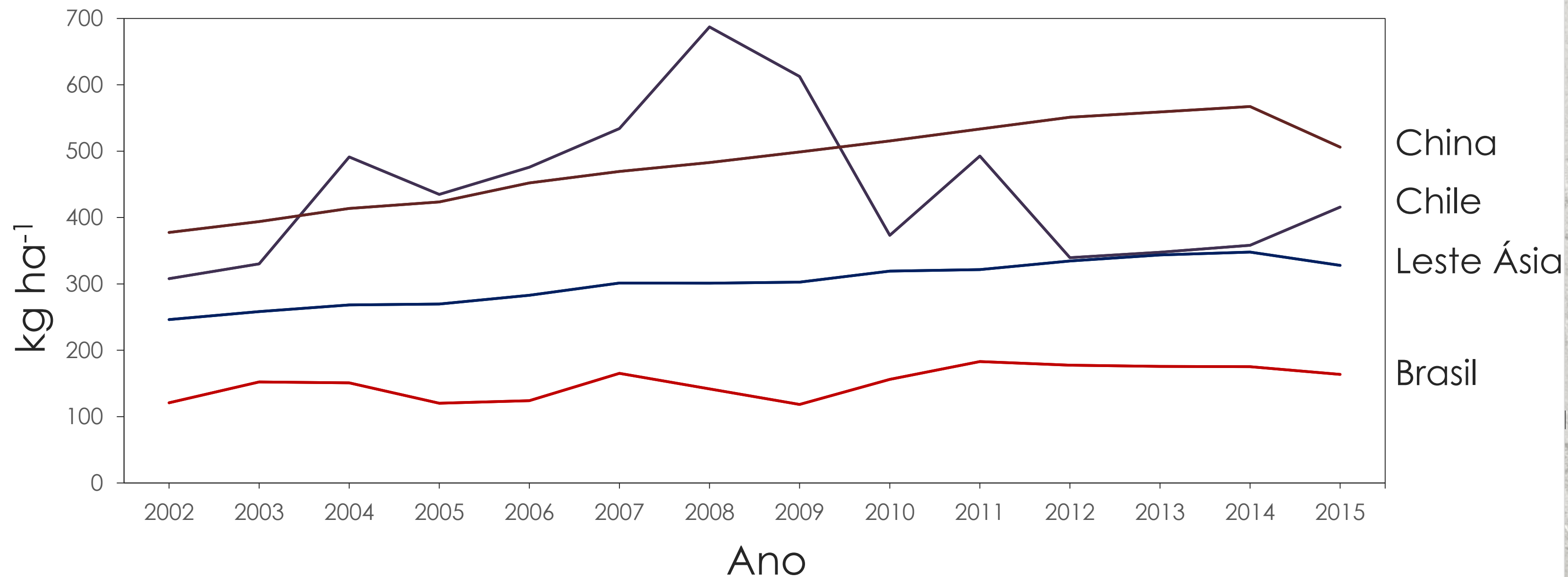


Fonte: <https://data.worldbank.org/indicador/AG.CON.FERT.ZS?view=map&year=2015>



# Consumo de nutrientes

## Países com taxas de consumo de NPK acima de 100 kg ha<sup>-1</sup>

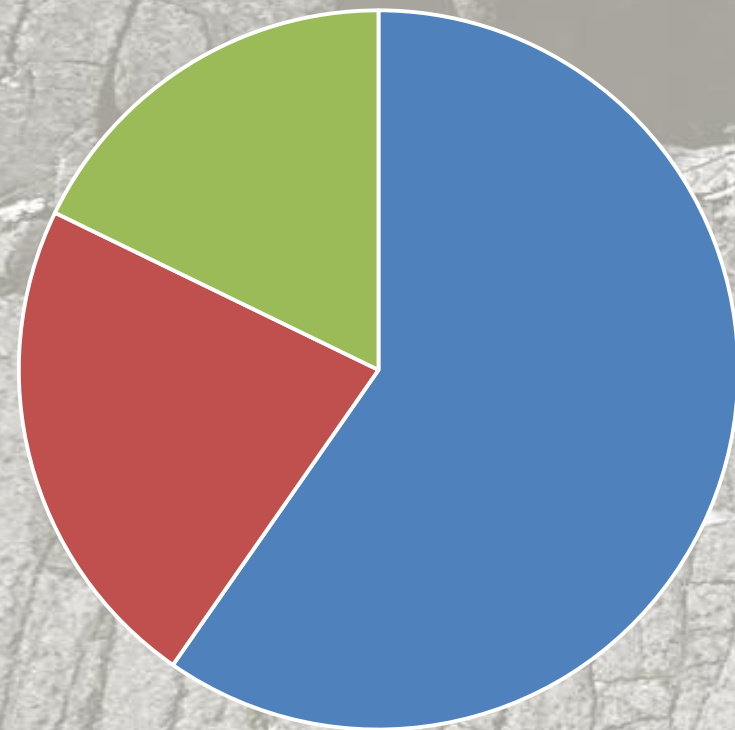


Fonte: <https://data.worldbank.org/indicador/AG.CON.FERT.ZS?view=map&year=2015>



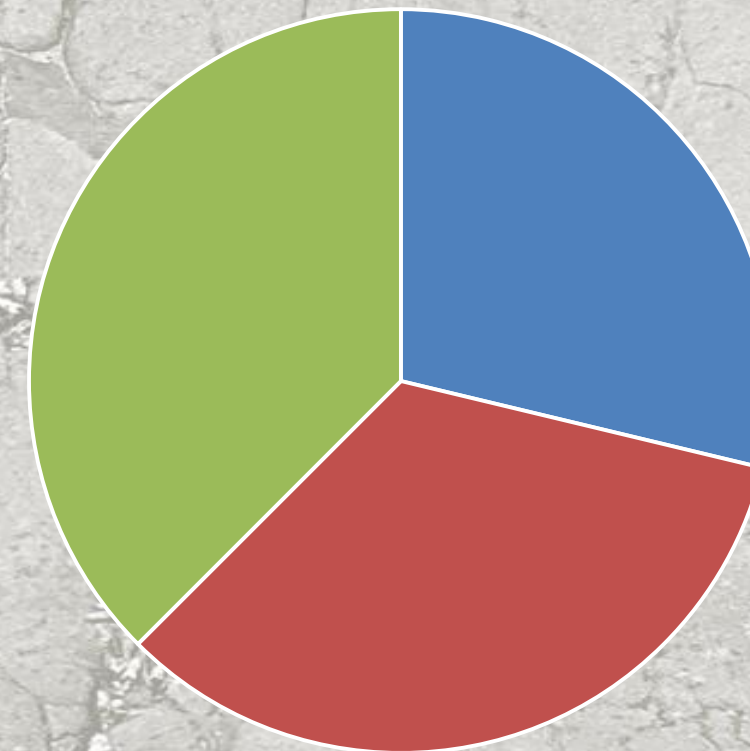
# Consumo de nutrientes

2017 (Mundo)



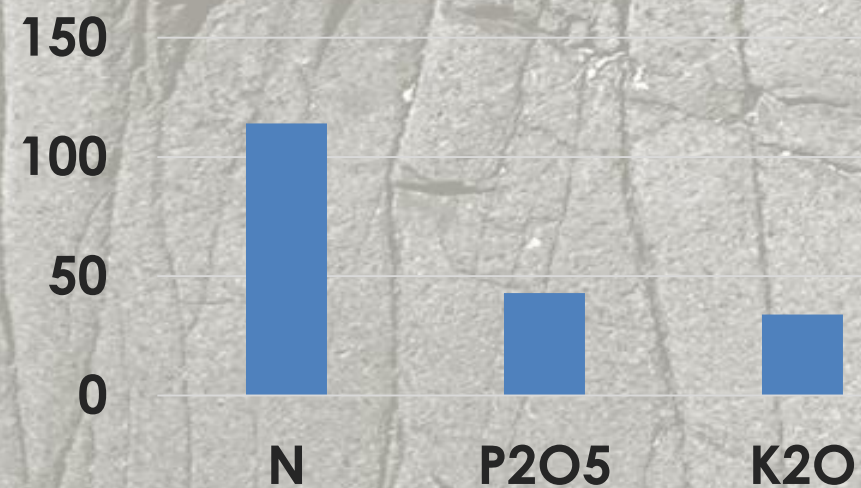
■ N ■ P2O5 ■ K2O

2017 (Brasil)

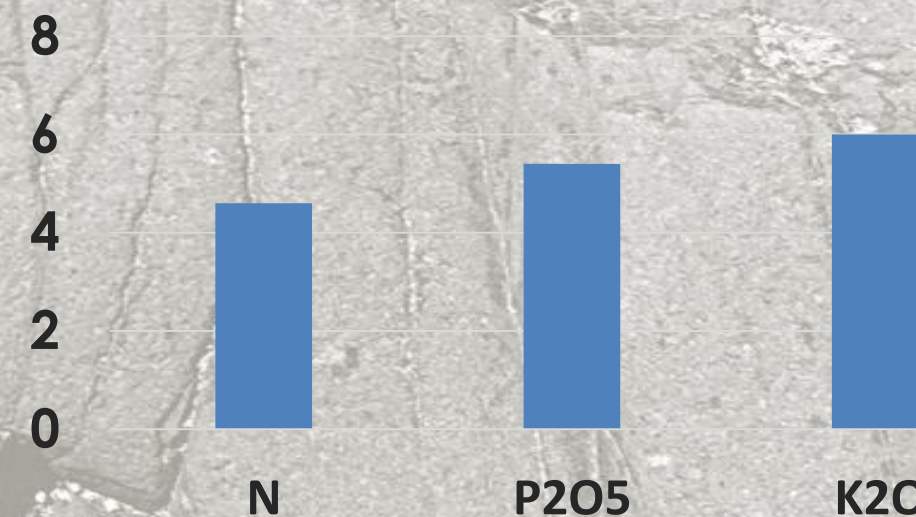


■ N ■ P2O5 ■ K2O

2017 – Mundo (10<sup>6</sup> ton)

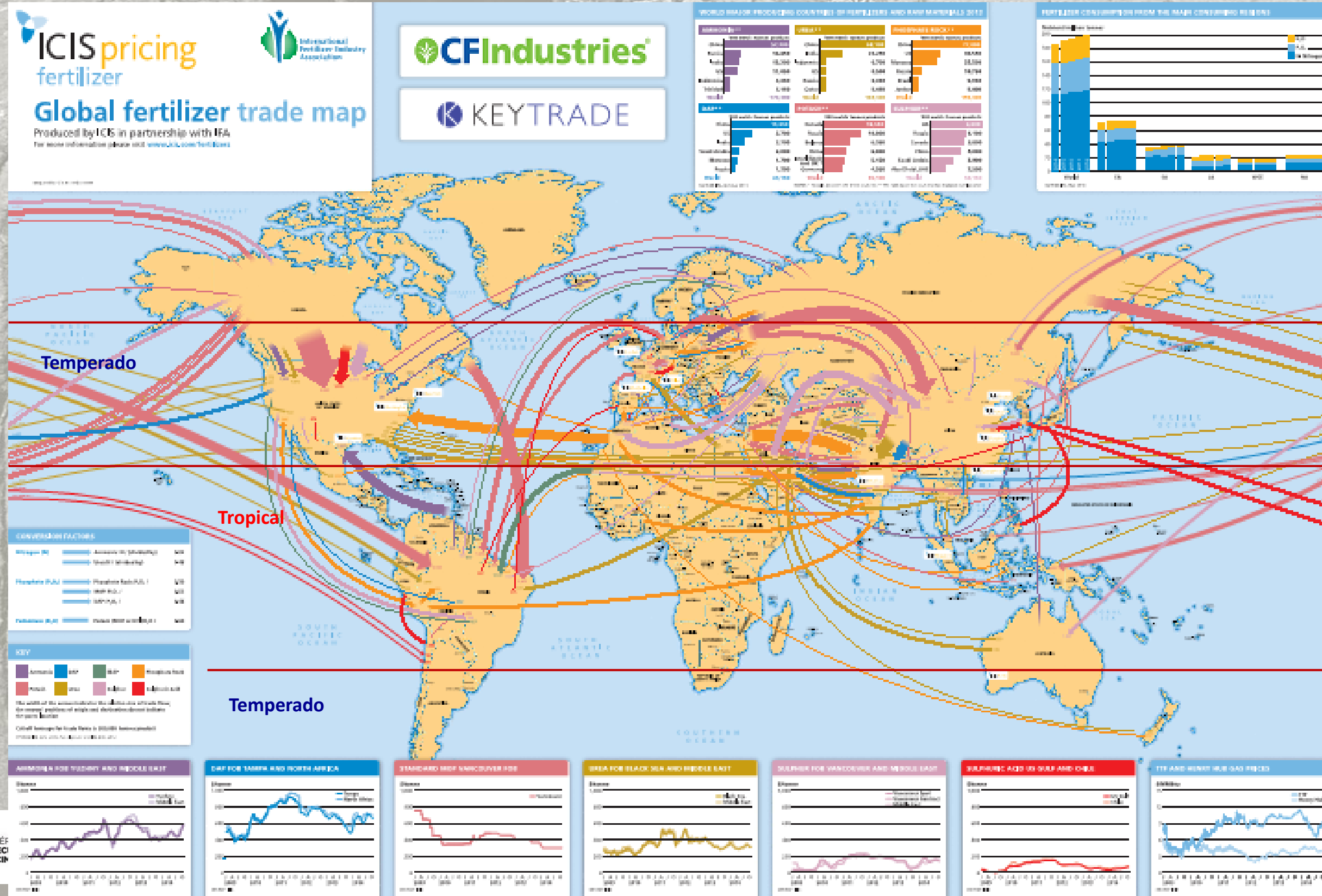


2017 – Brasil (10<sup>6</sup> ton)





# Commodities fertilizantes

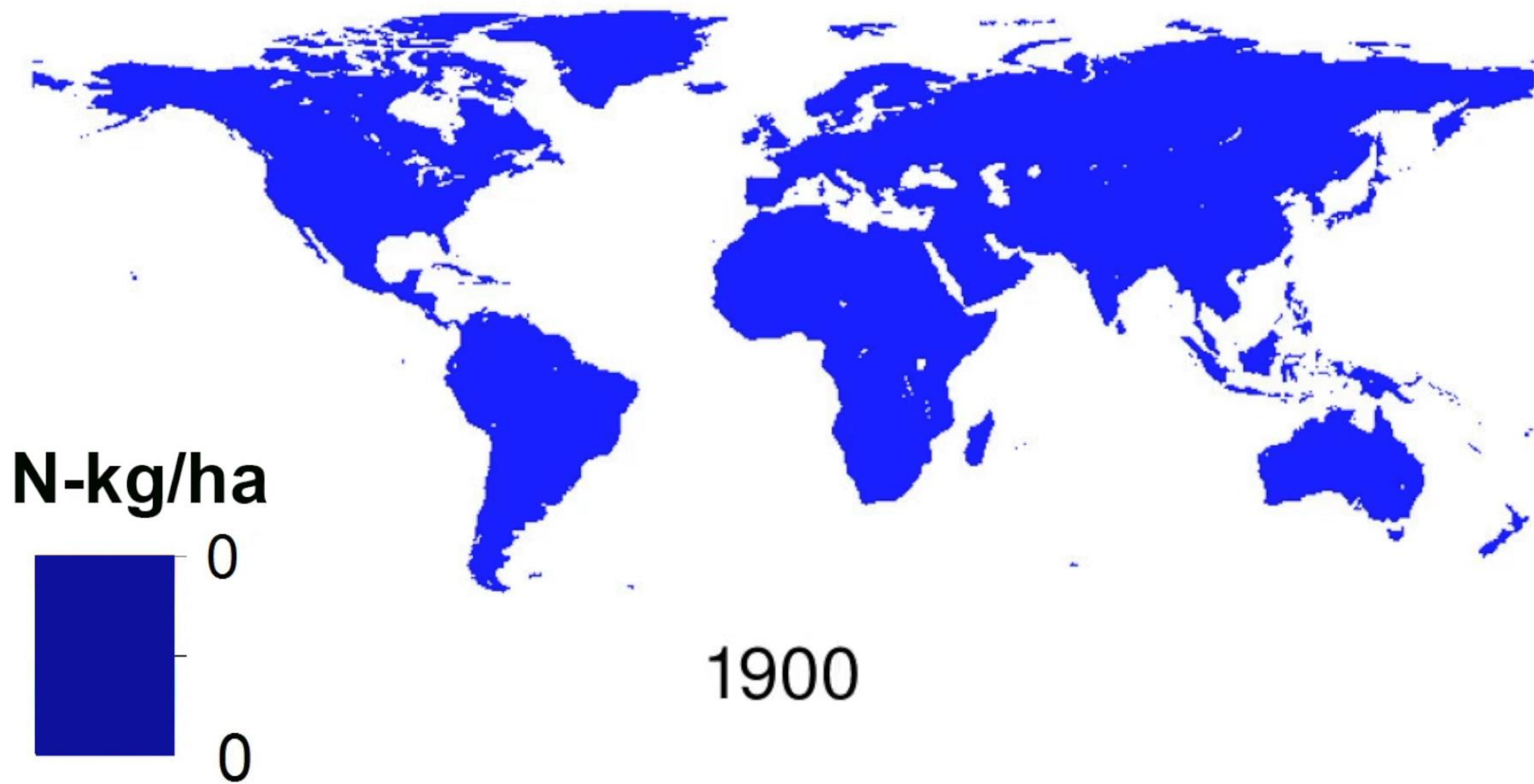




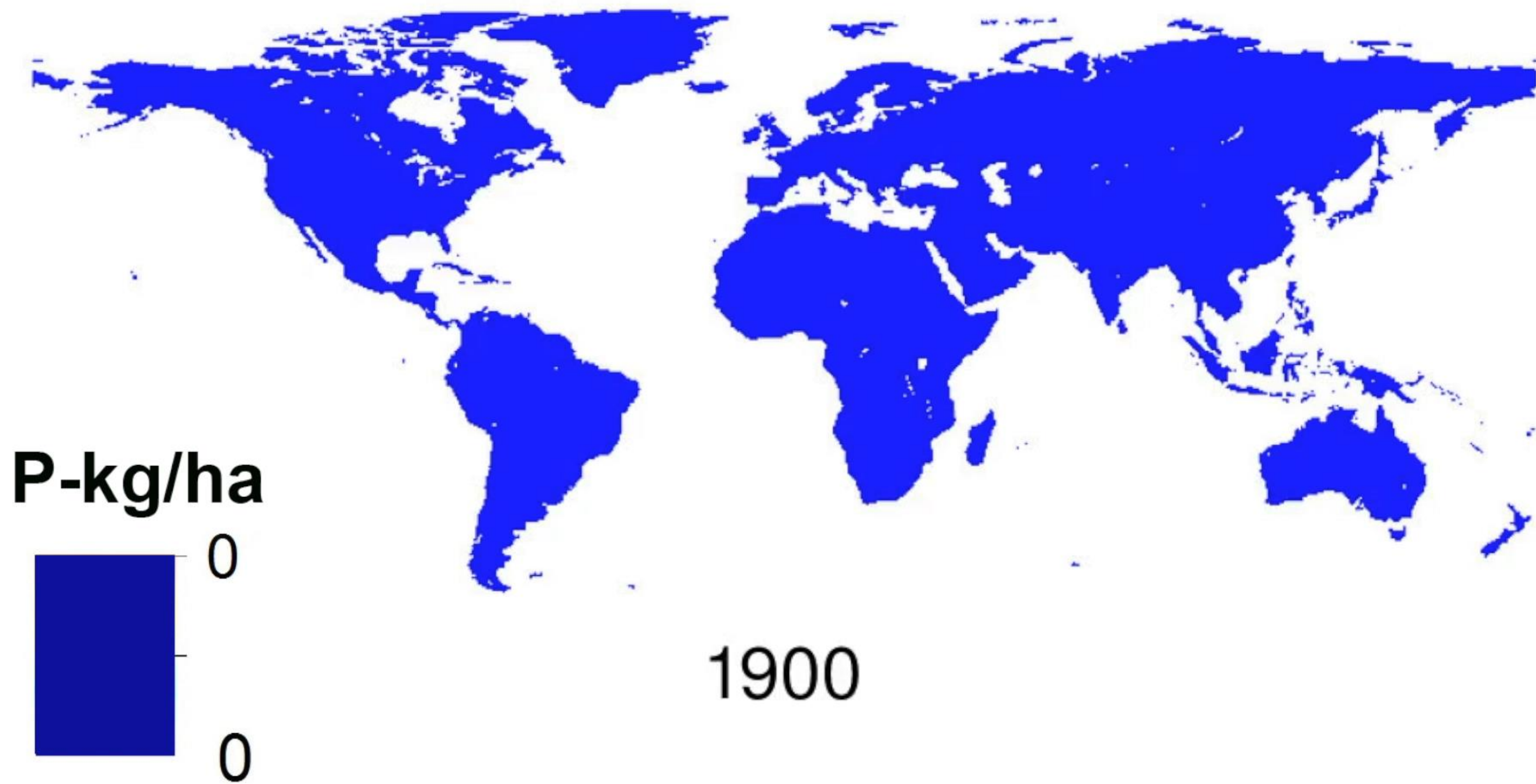
# Commodities fertilizantes

[Lu, Chaoqun; Tian, Hanqin \(2016\):](#) Half-degree gridded nitrogen and phosphorus fertilizer use for global agriculture production during 1900-2013. *PANGAEA*, <https://doi.org/10.1594/PANGAEA.863323>



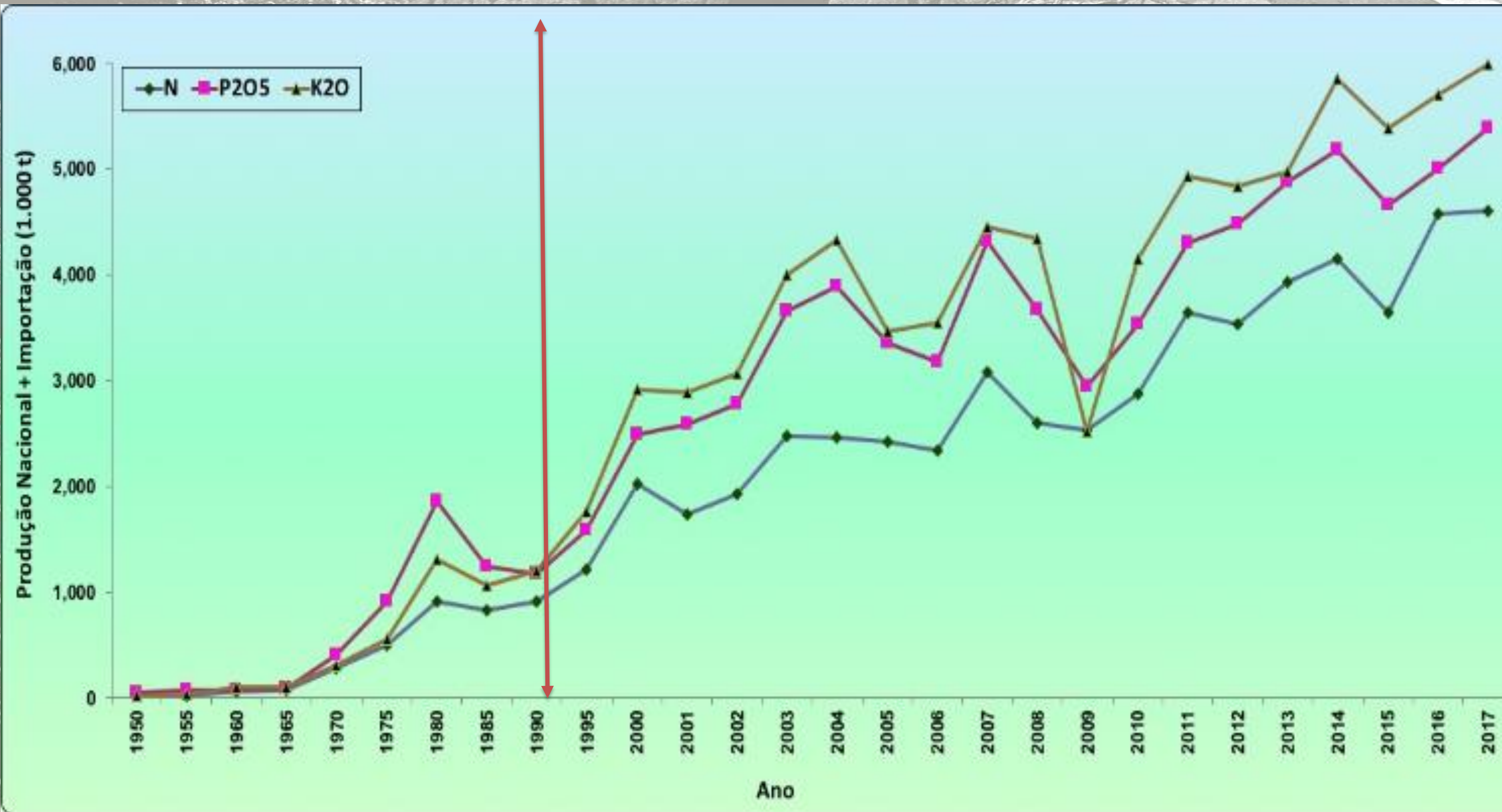








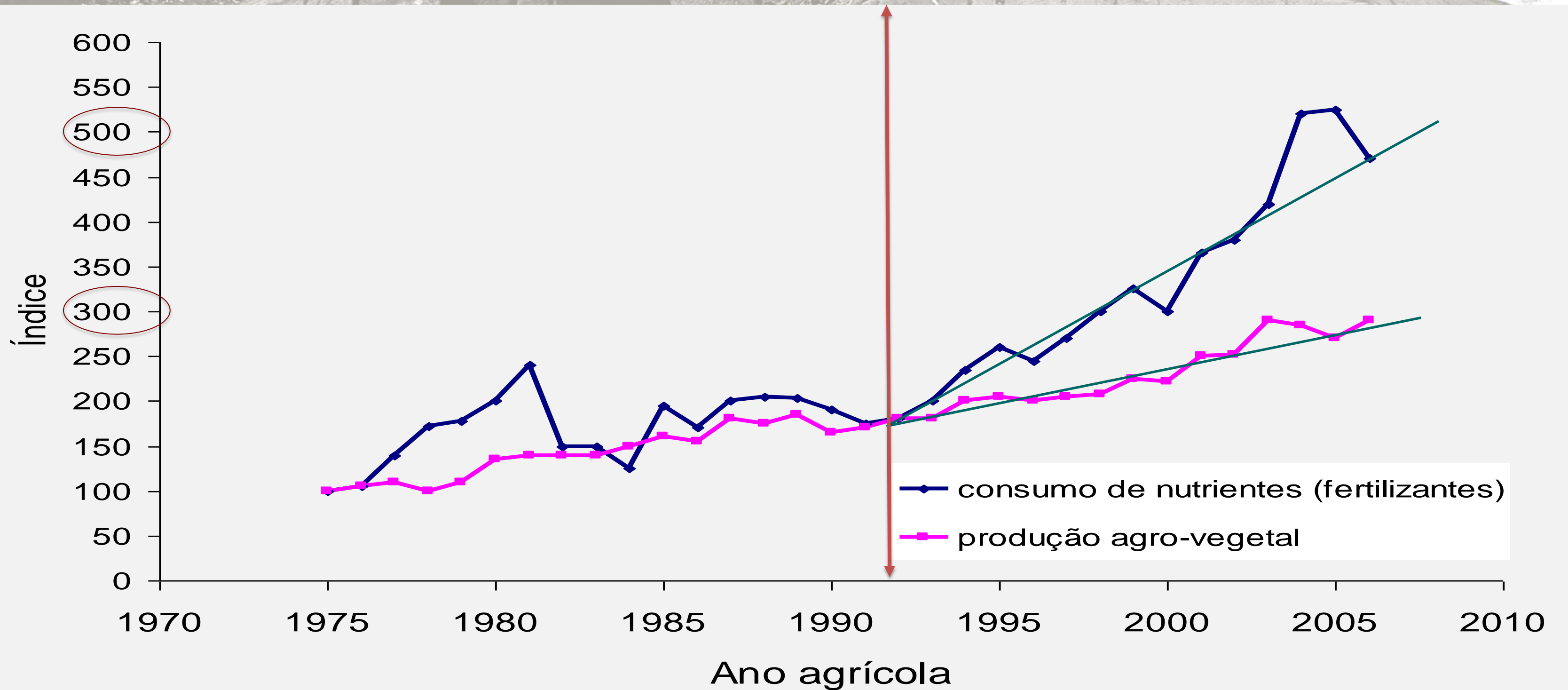
# Dependência Externa



6,0 10<sup>6</sup> ton K<sub>2</sub>O: 95%  
5,4 10<sup>6</sup> ton P<sub>2</sub>O<sub>5</sub>: 64%  
4,6 10<sup>6</sup> ton N: 88%

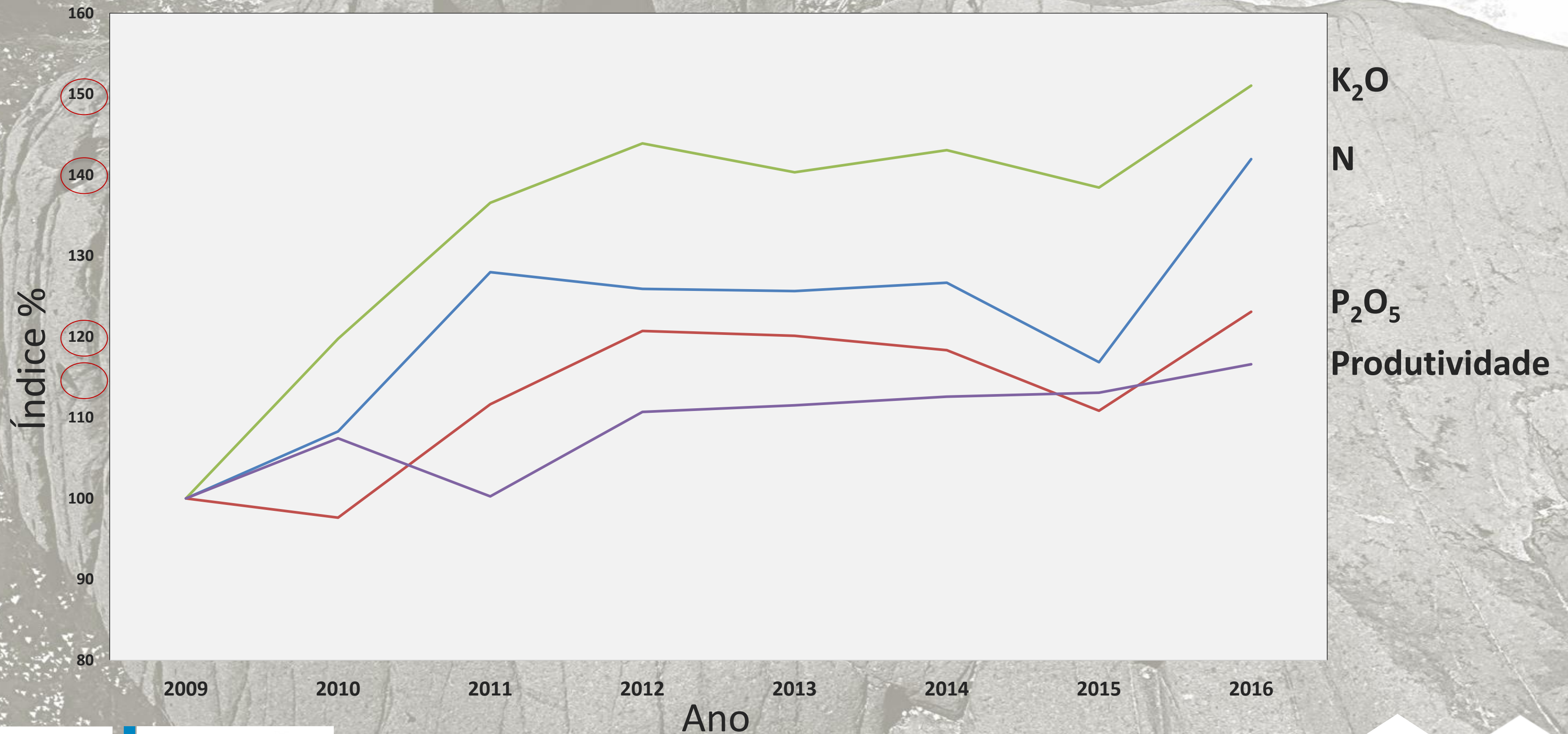


# Eficiência de uso de nutrientes



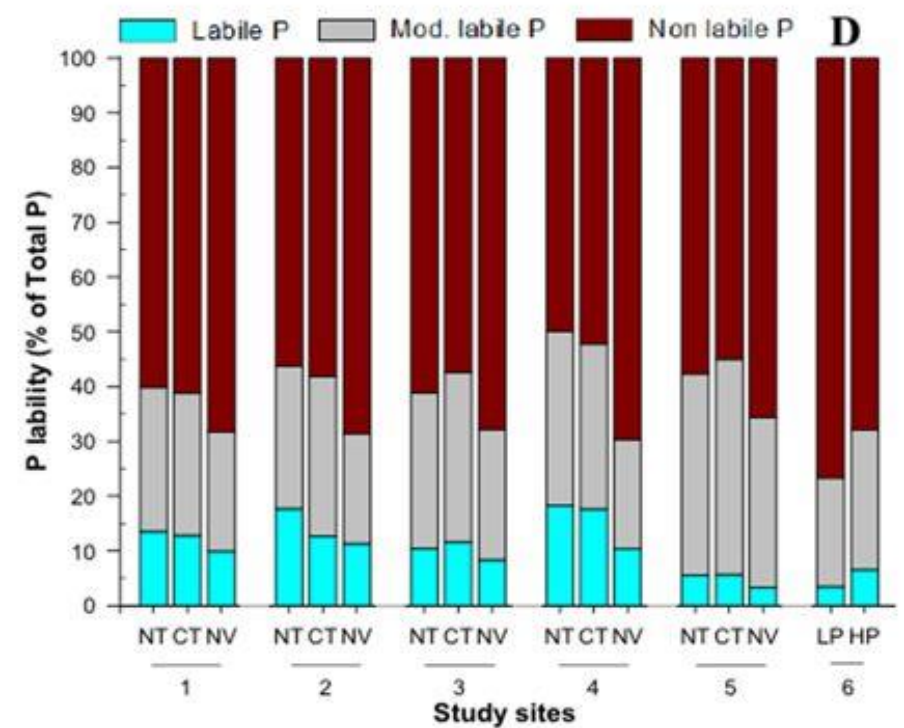
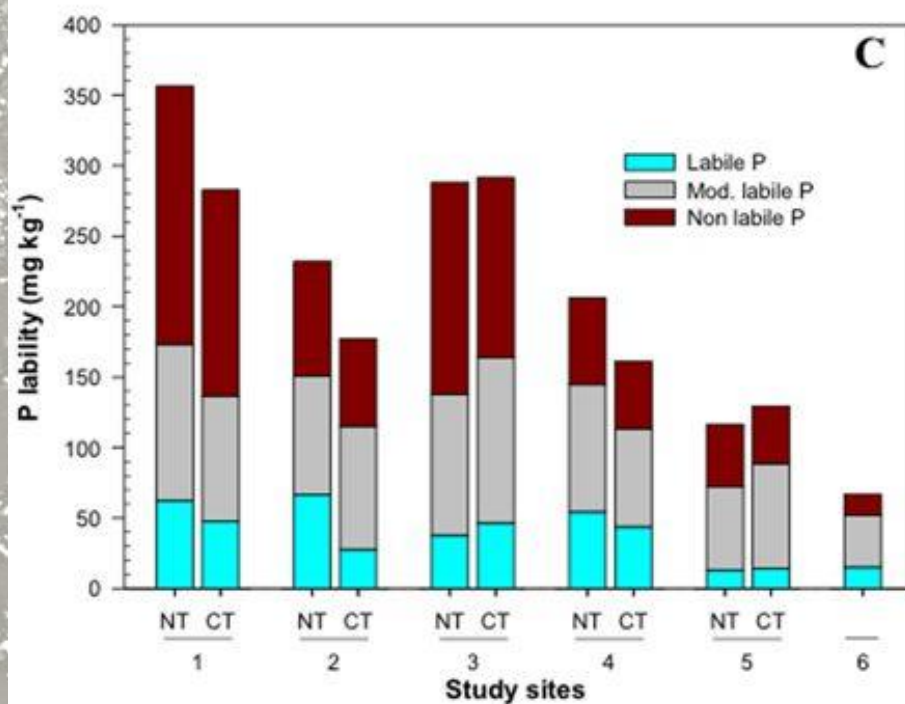
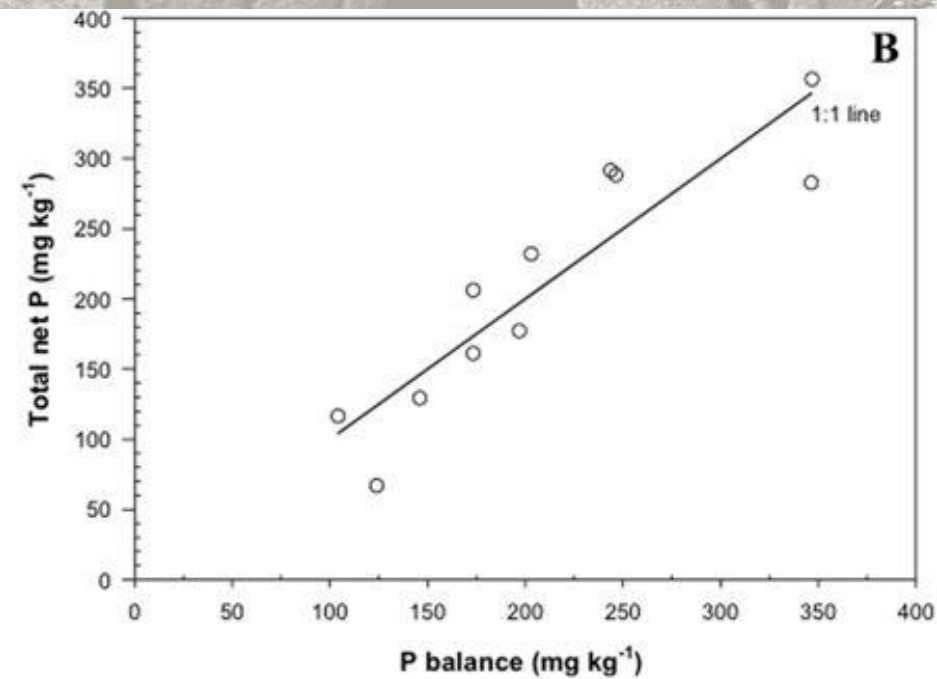
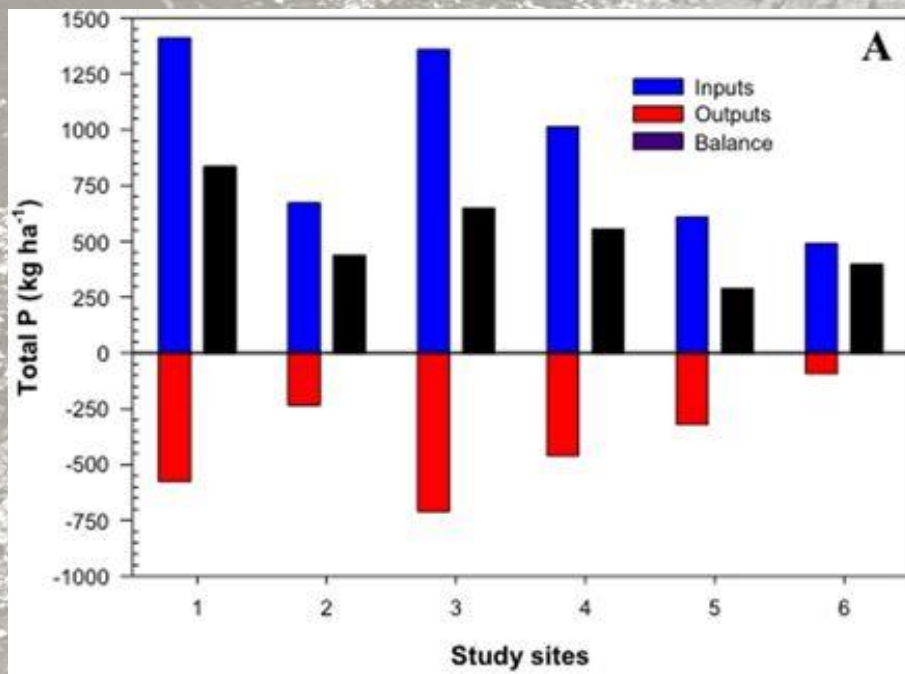


# Eficiência de uso de nutrientes





# Adsorção de P em solos de clima tropical



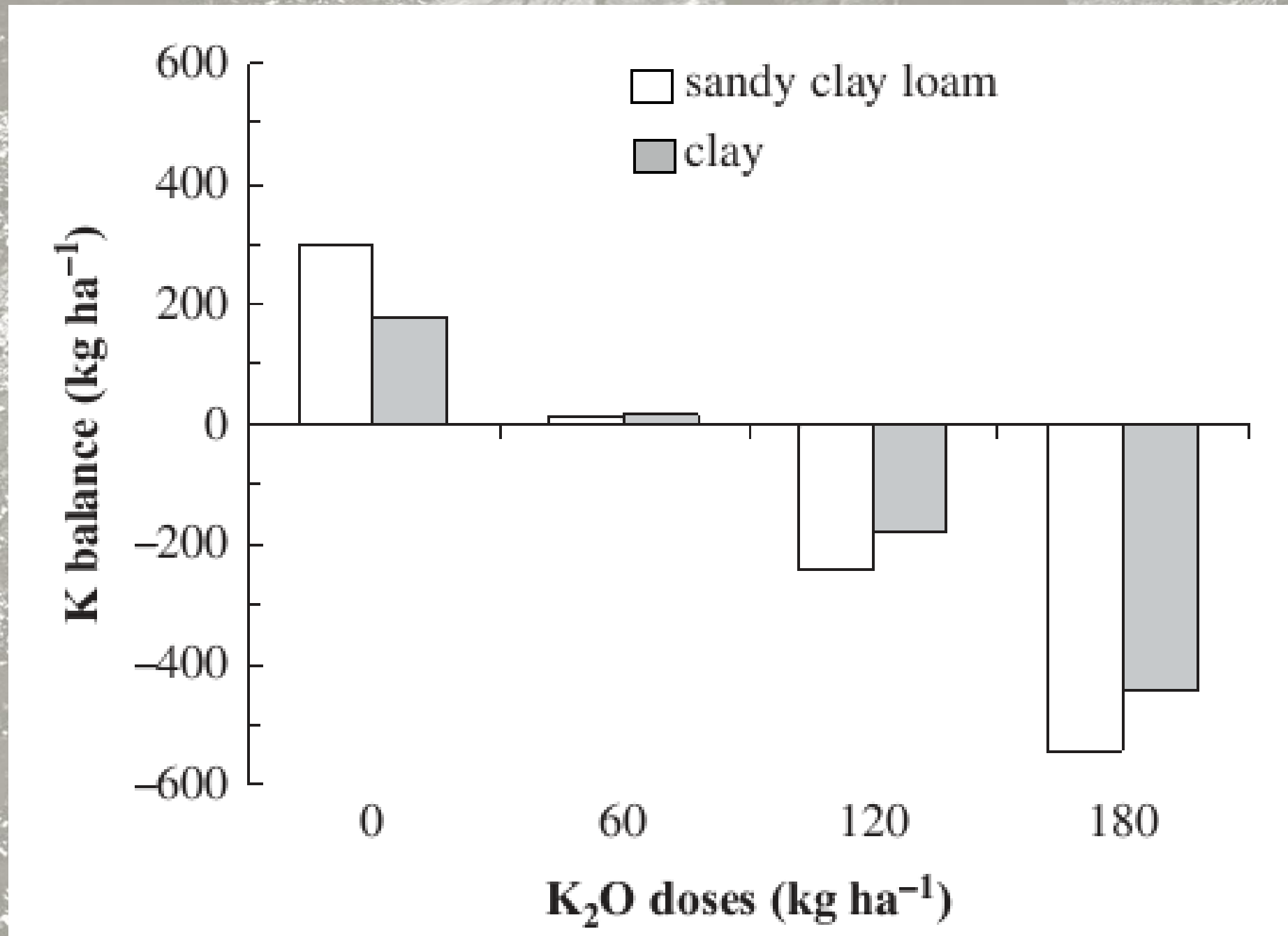
Balanço do P em solos agrícola do Brasil:

- ✓ ~ metade do P aplicado continua no solo
- ✓ Equivale a recursos de hoje U\$42 bilhões

Withers et al. 2018 Nature doi: 10.1038/s41598-018-20887-z



# Eficiência de uso de nutrientes



Balanço do K na camada 0-20 cm.

Soja 6 anos

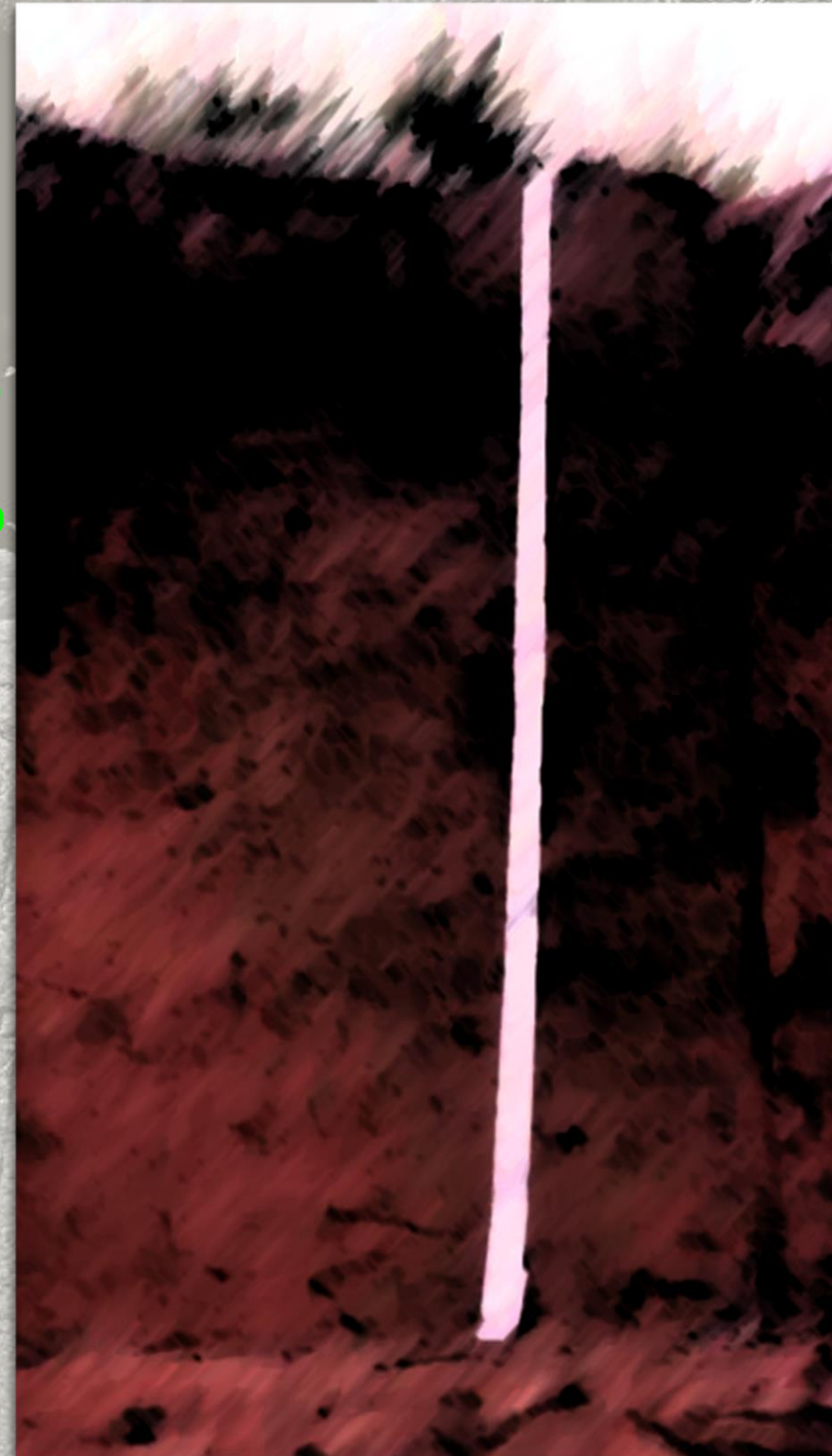
- ✓ Utilização eficiente apenas para subdoses
- ✓ Perdas nas doses praticadas

Rosoloem et al. (2010) Communications in Soil Science and Plant Analysis, 41: 16, 1934-1943. doi: 10.1080/00103624.2010.495804



# Remineralização de solos

## Formação de camada superficial



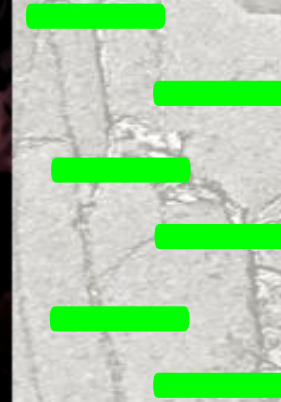
Alta capacidade de troca de cátions (CTC)



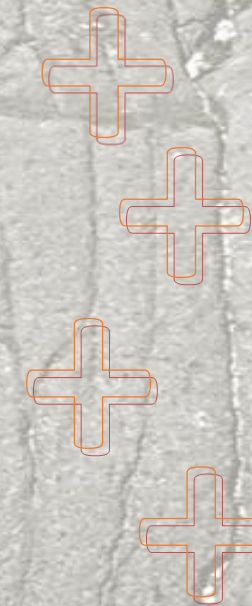
Alta capacidade de troca de ânions (CTA)



Cations:  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^+$

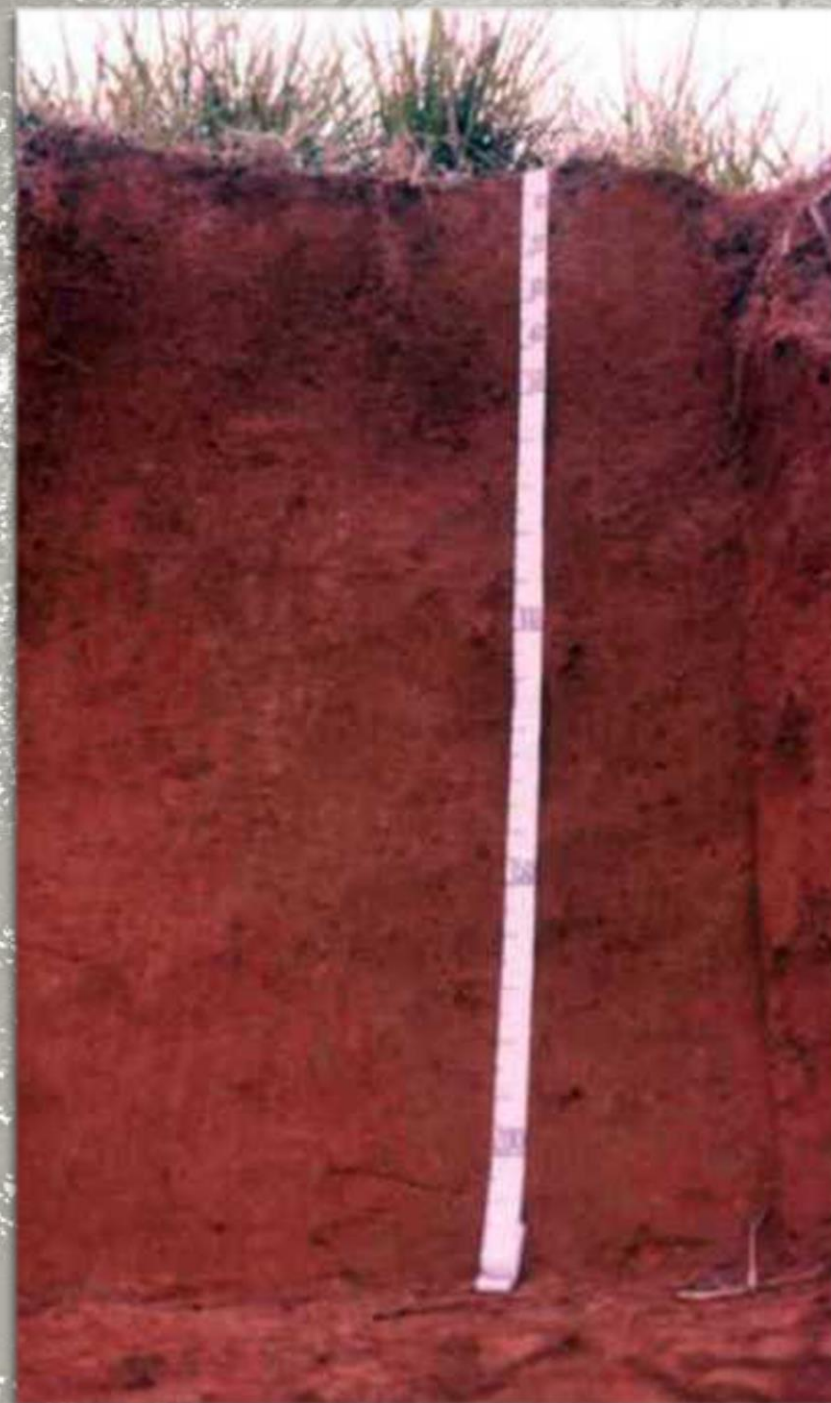


Anions:  $\text{SiO}_4^{-4}$ ,  $\text{PO}_4^{3-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_4^-$





# Formação de solo



1 cm a cada 50 ou 100 anos  
(1 a 2 toneladas por ano)

Processo natural:  
1 cm a cada 1.000 anos



# Aumento das raízes das culturas



Fonte: Embrapa Cerrados 2017



# Aumento de Raízes da Culturas







# Abordagem metodológica

Zonas de ocorrência potencial de agrominerais

Integração de dados (banco de dados CPRM)

Classificação por classe de agromineral

Definição de restrições legais e econômicas

Avaliação do potencial de ocorrência

Zonas de consumo de agrominerais

Censo IBGE; ANDA

Consumo definido pela recomendação e exportação de nutrientes

Comparação com consumo aparente

Espacialização dos dados por microrregião e por uso da terra

Integração

Definição de zonas de potencial econômico para produção de agrominerais

Definição de zonas de carência de agrominerais e alto consumo





# Dados Utilizados

Potencial  
Geológico

Geologia 1:1.000.000

Litoquímica (Rocha)

Afloramentos

Recursos Minerais

Poligonais DNPM (Lavra, Lavra Garimpeira, Req. Lavra, Req. Lavra Garimpeira)

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SRTM- Declividade

MapBiomas V3.0 (Uso e ocupação do terreno)

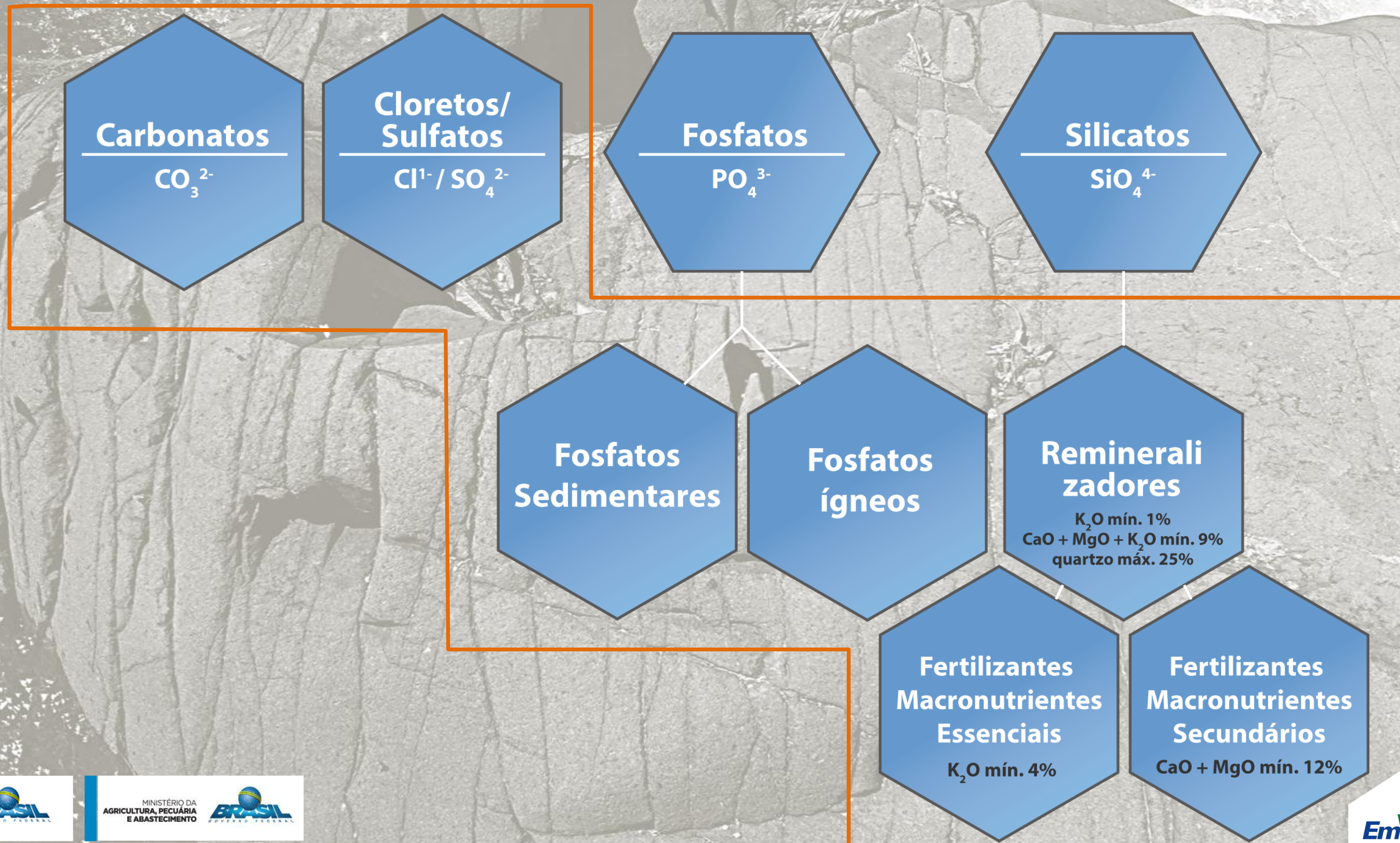
UC's - Unidades de Conservação Ambiental

TI's – Terras Indígenas

Restrições  
Econômicas/  
Ambientais



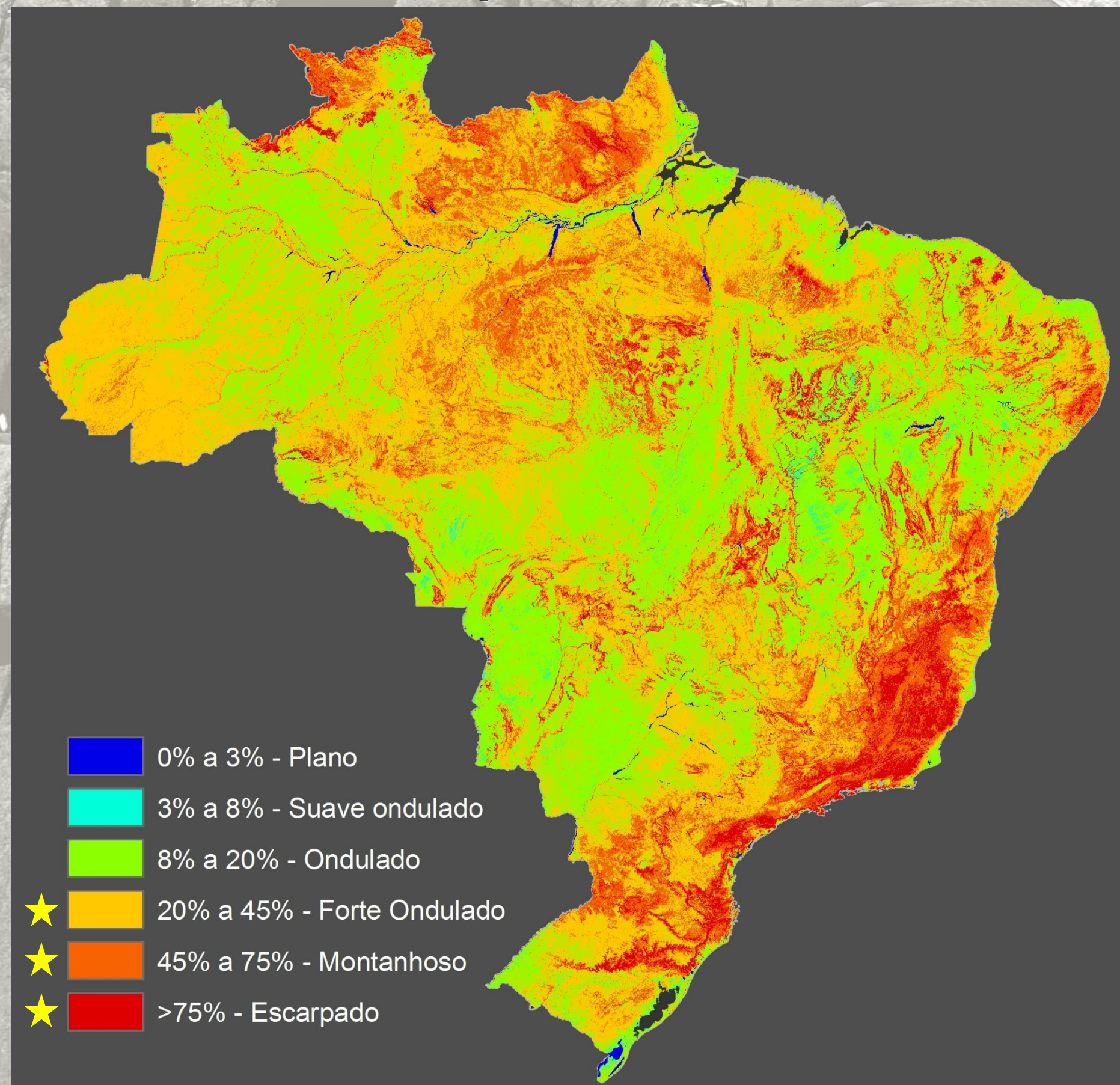
# Classificação





# Restrições Econômicas/ Ambientais

## SRTM Declividade



Obs.:

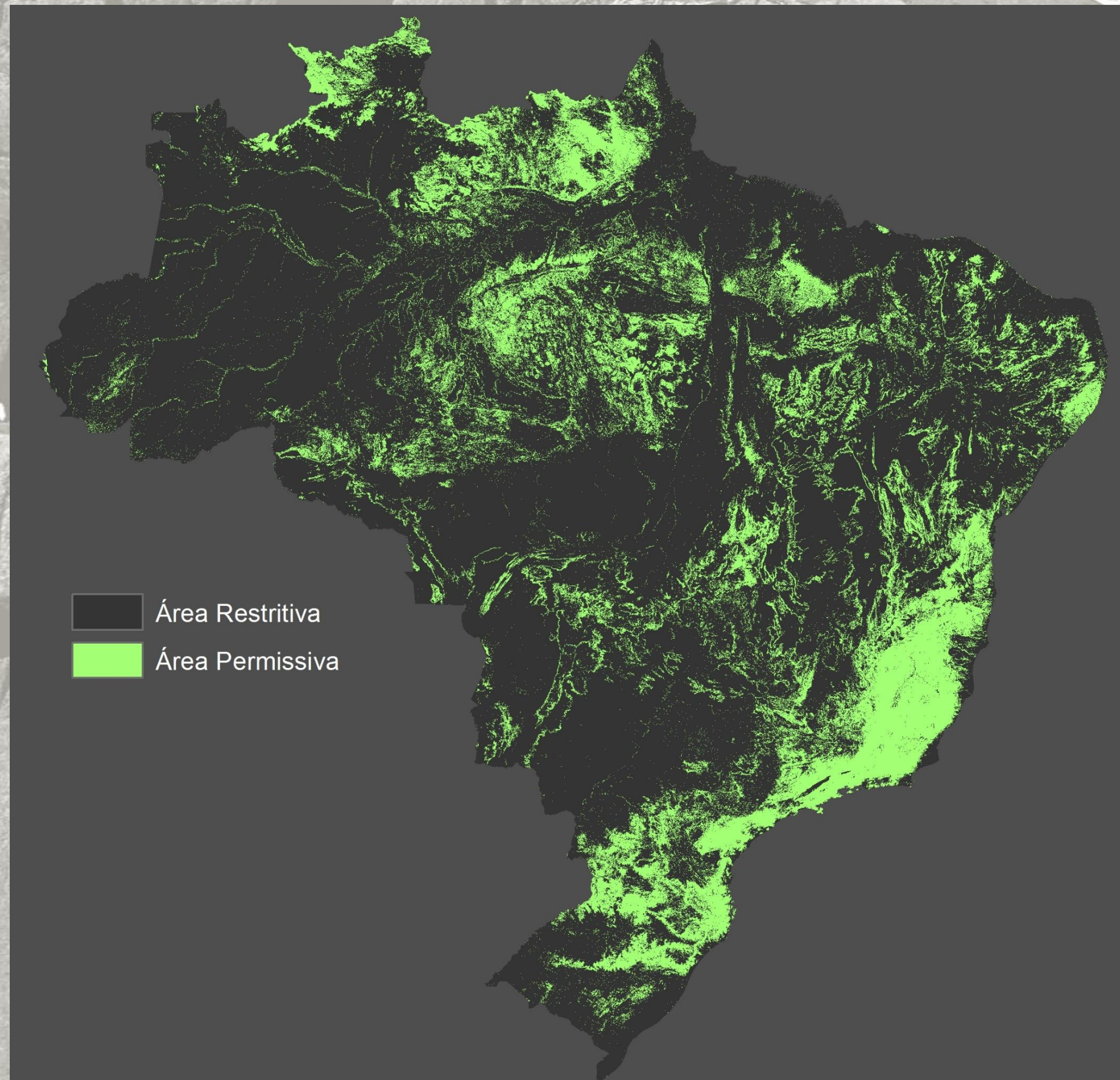
Classes sem restrição de declividade:

- Cloretos/Sulfatos
- Fosfato ígneo



# Restrições Econômicas/ Ambientais

## SRTM Declividade

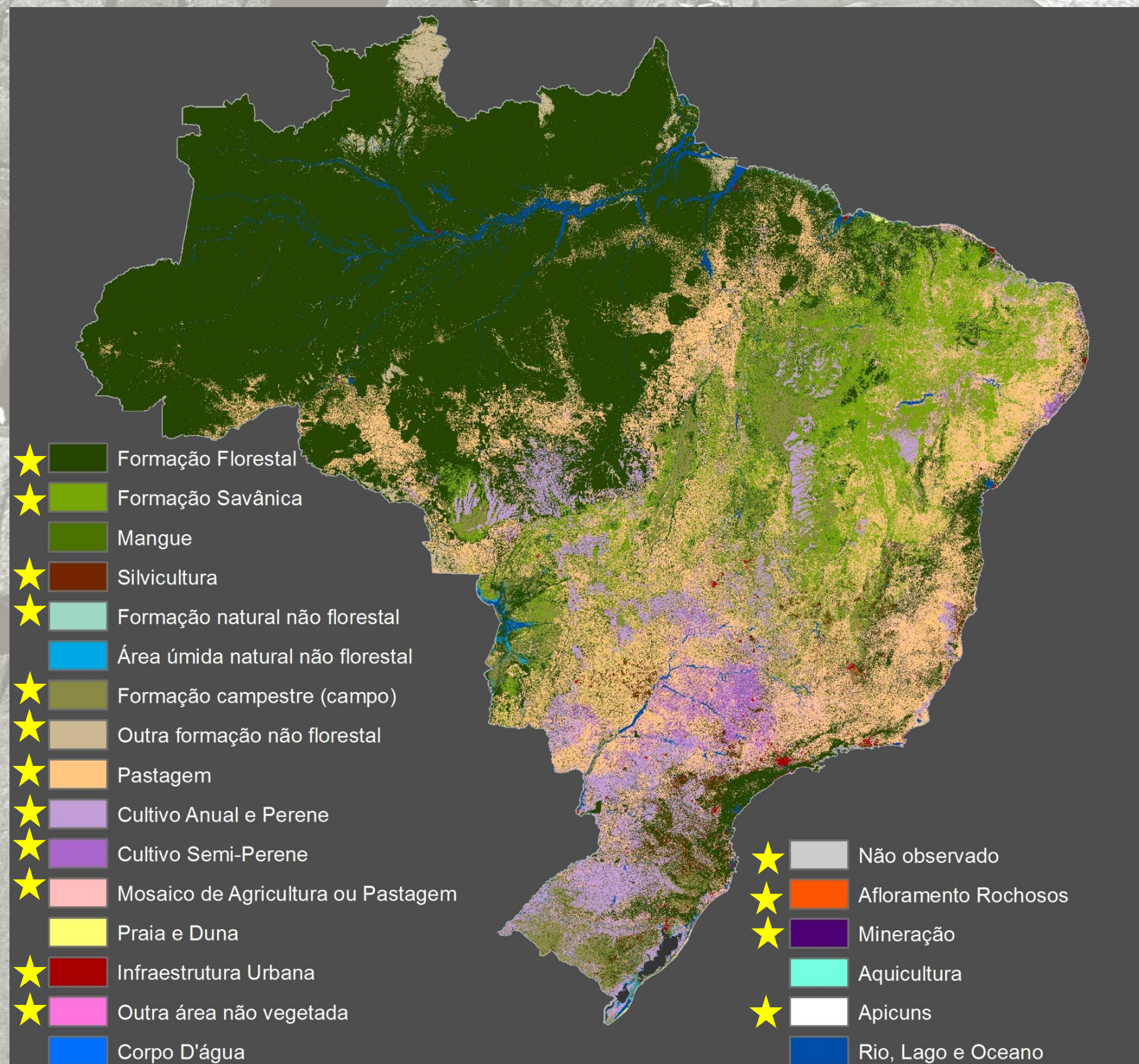




# Restrições Econômicas/ Ambientais

## MapBiomas V3.0

★ Classes Permissivas





# Restrições Econômicas/ Ambientais

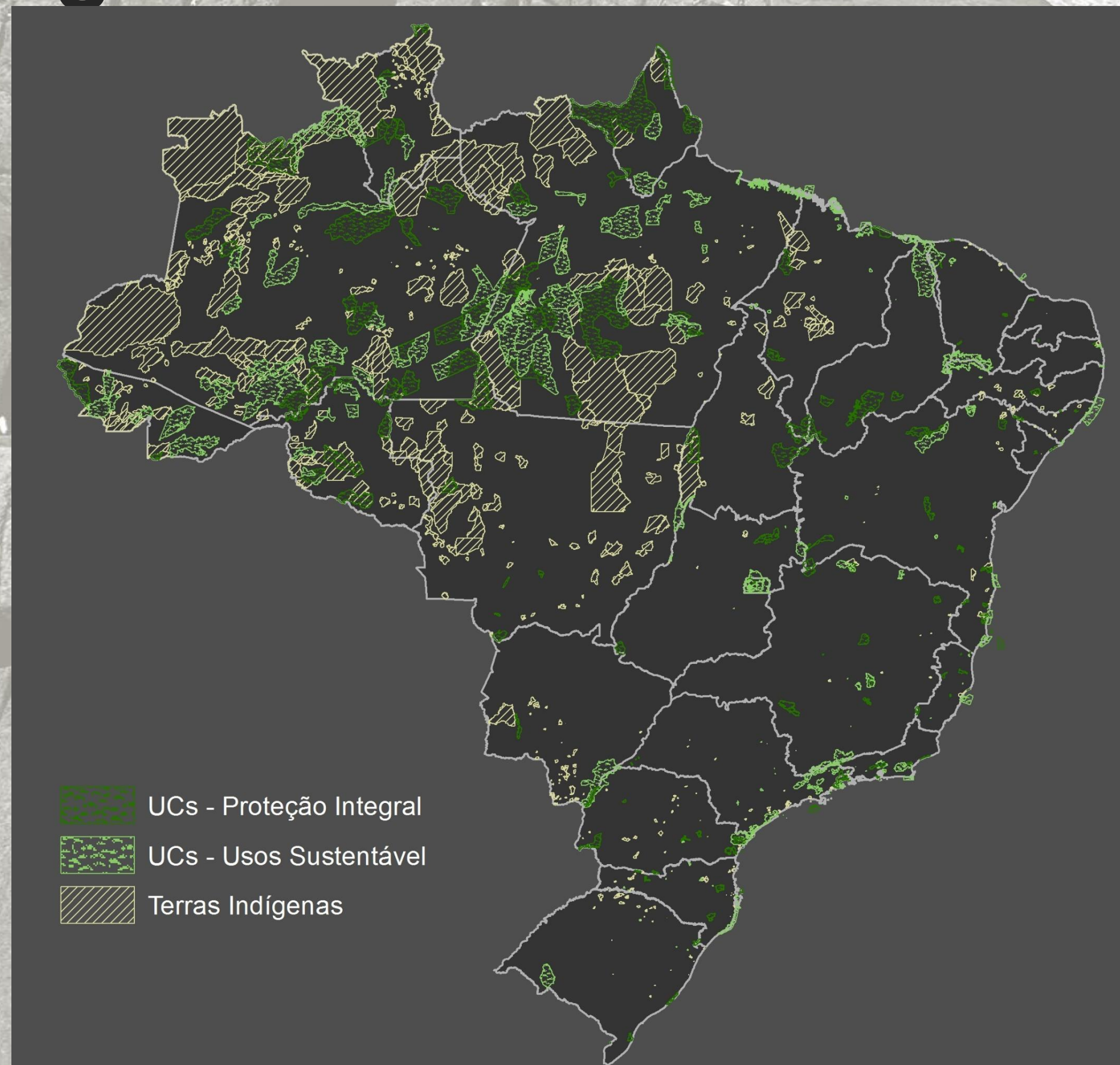
MapBiomas V3.0





# Restrições Legais

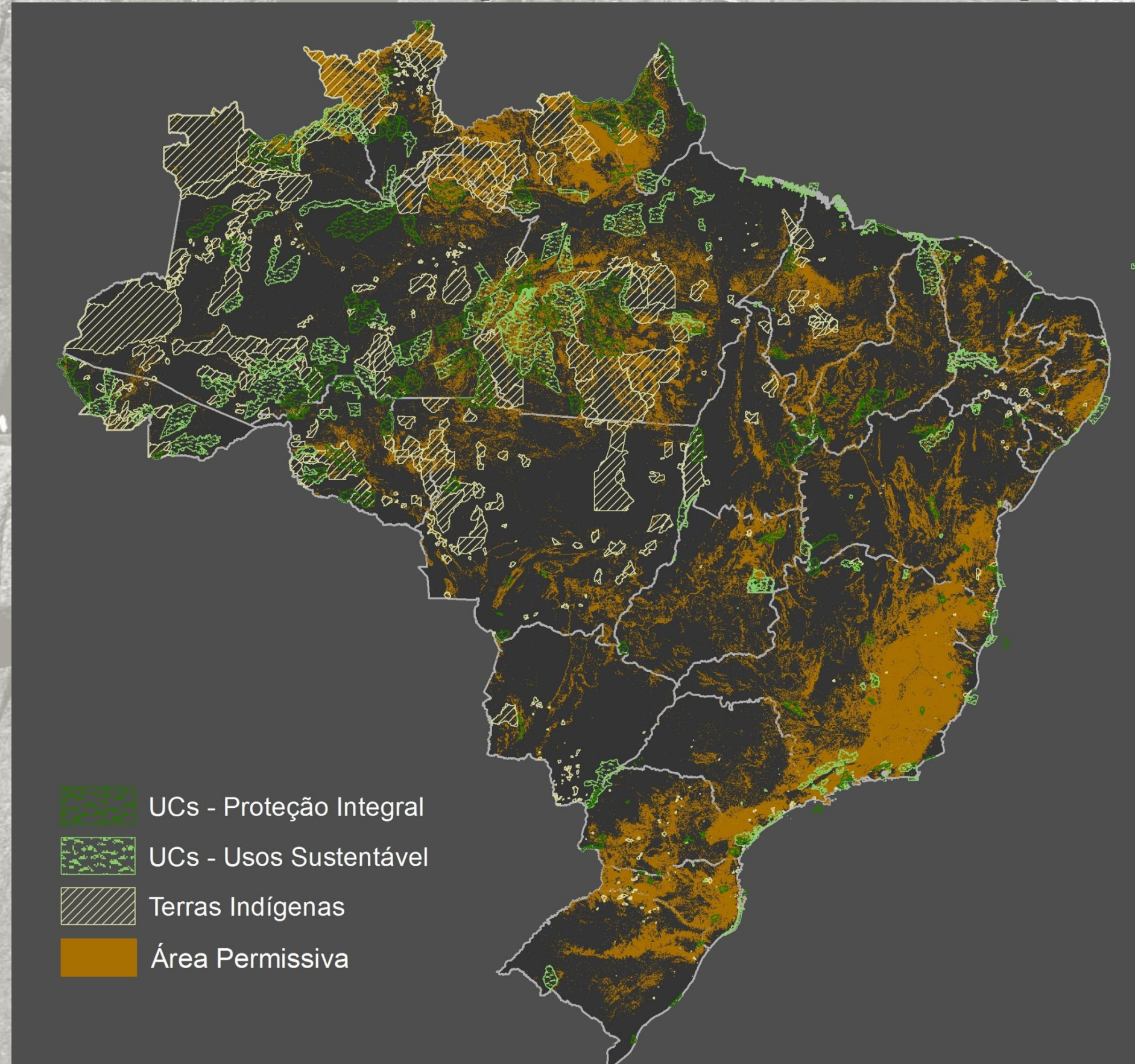
## UC's e TI's

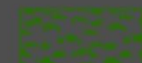






# Restrições Econômicas/ Ambientais/ Legais

Restrição Final



-  UCs - Proteção Integral
-  UCs - Usos Sustentável
-  Terras Indígenas
-  Área Permissiva

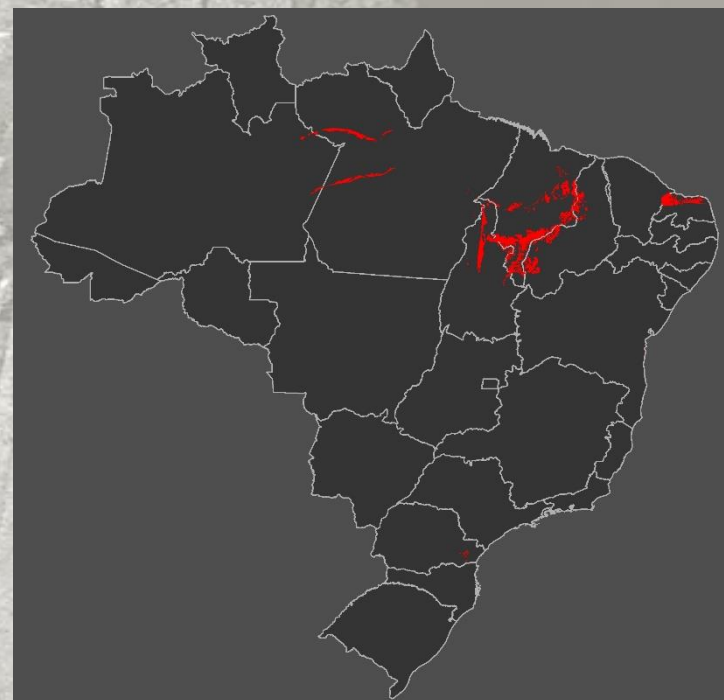


# Potencial de Ocorrência de Agrominerais



# Cloretos/ Sulfatos

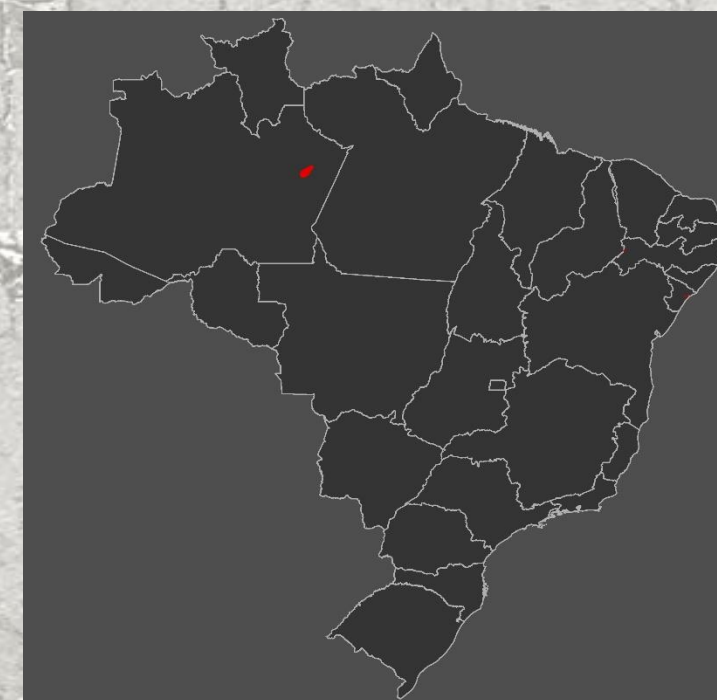
Lito. Evaporitos



Rec. Min. Cloretos



ARIM Cloretos



DNPM Cloretos

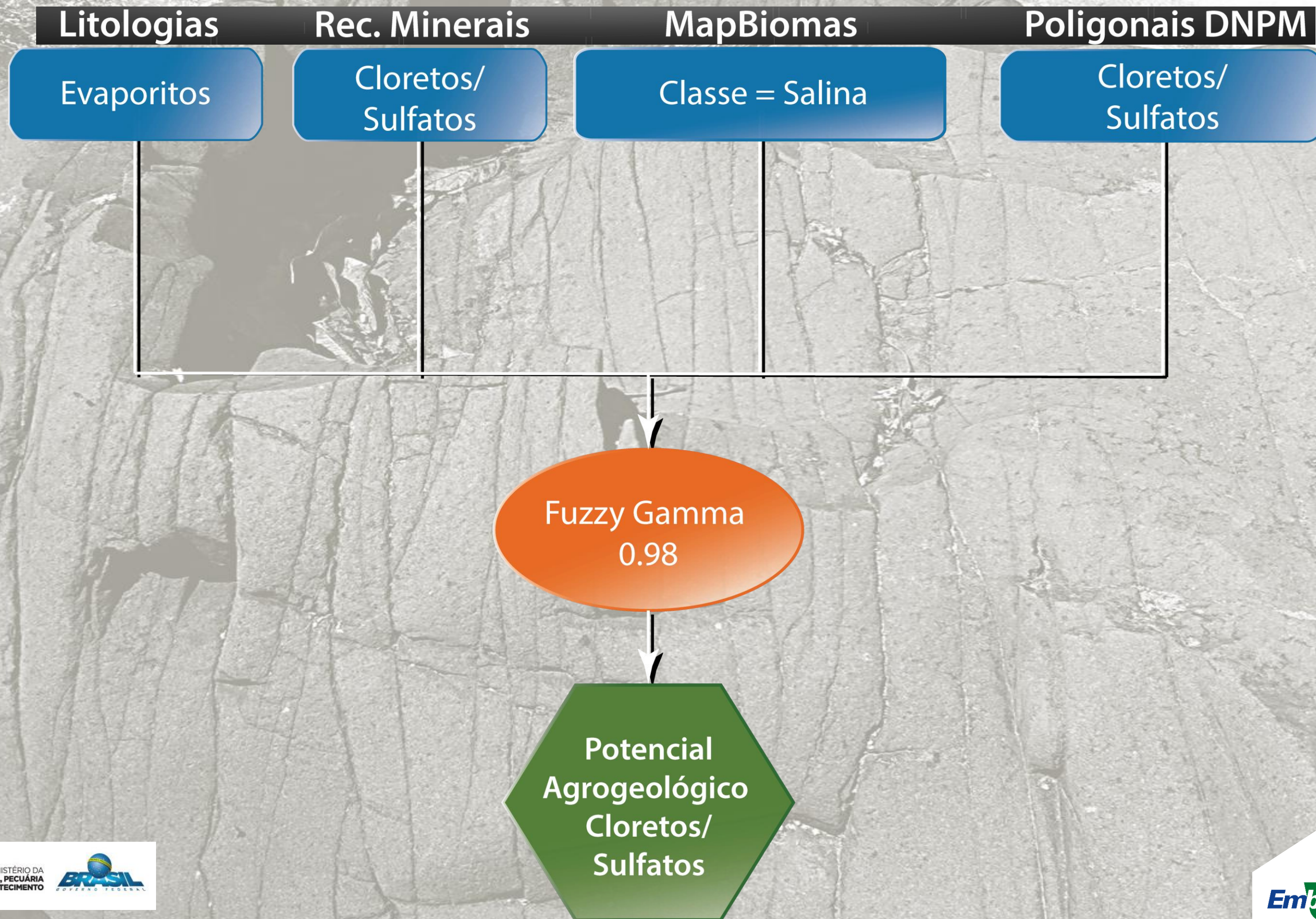


MapBiomas Sal





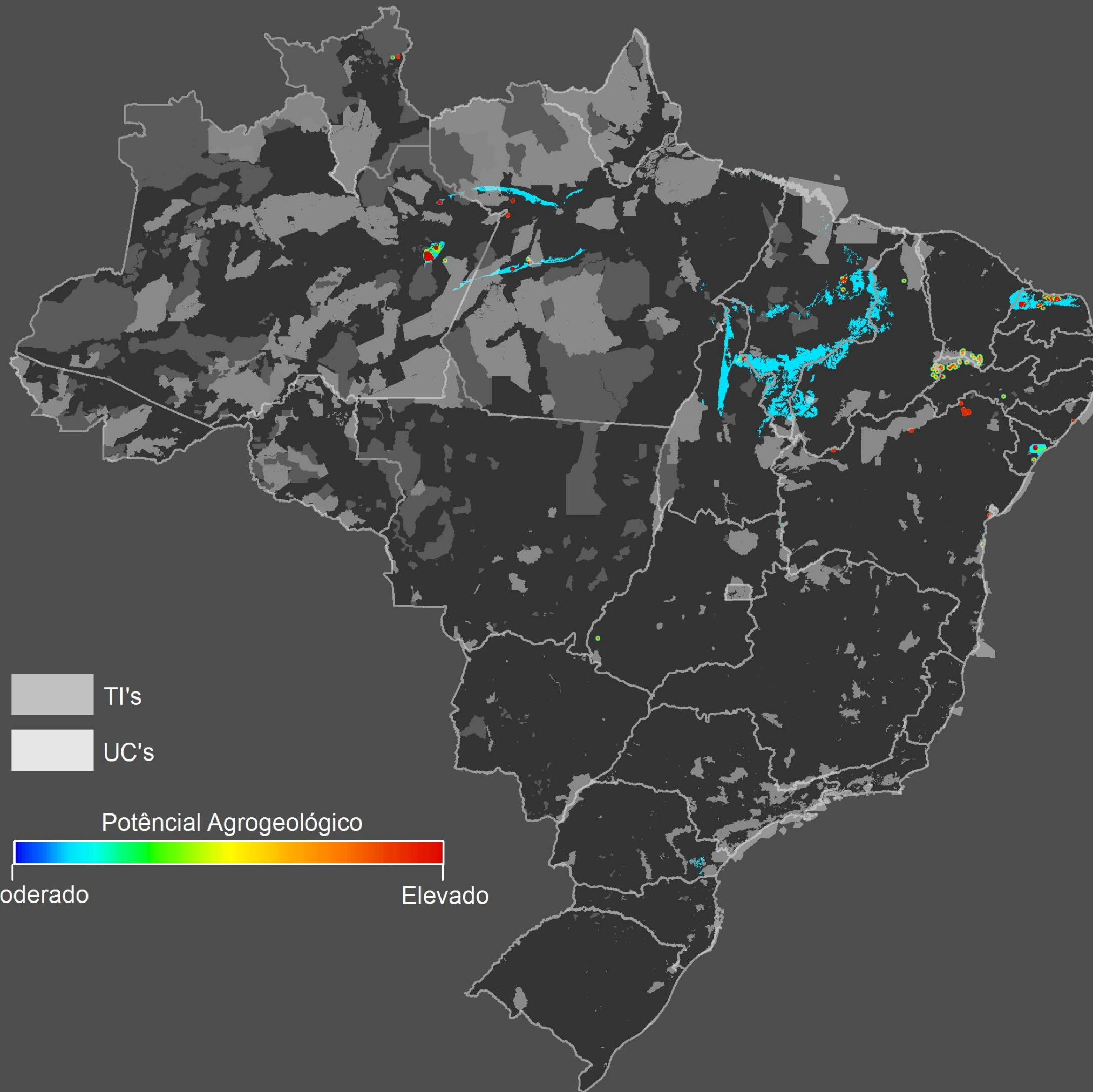
# Cloretos/Sulfatos





# Cloretos/ Sulfatos

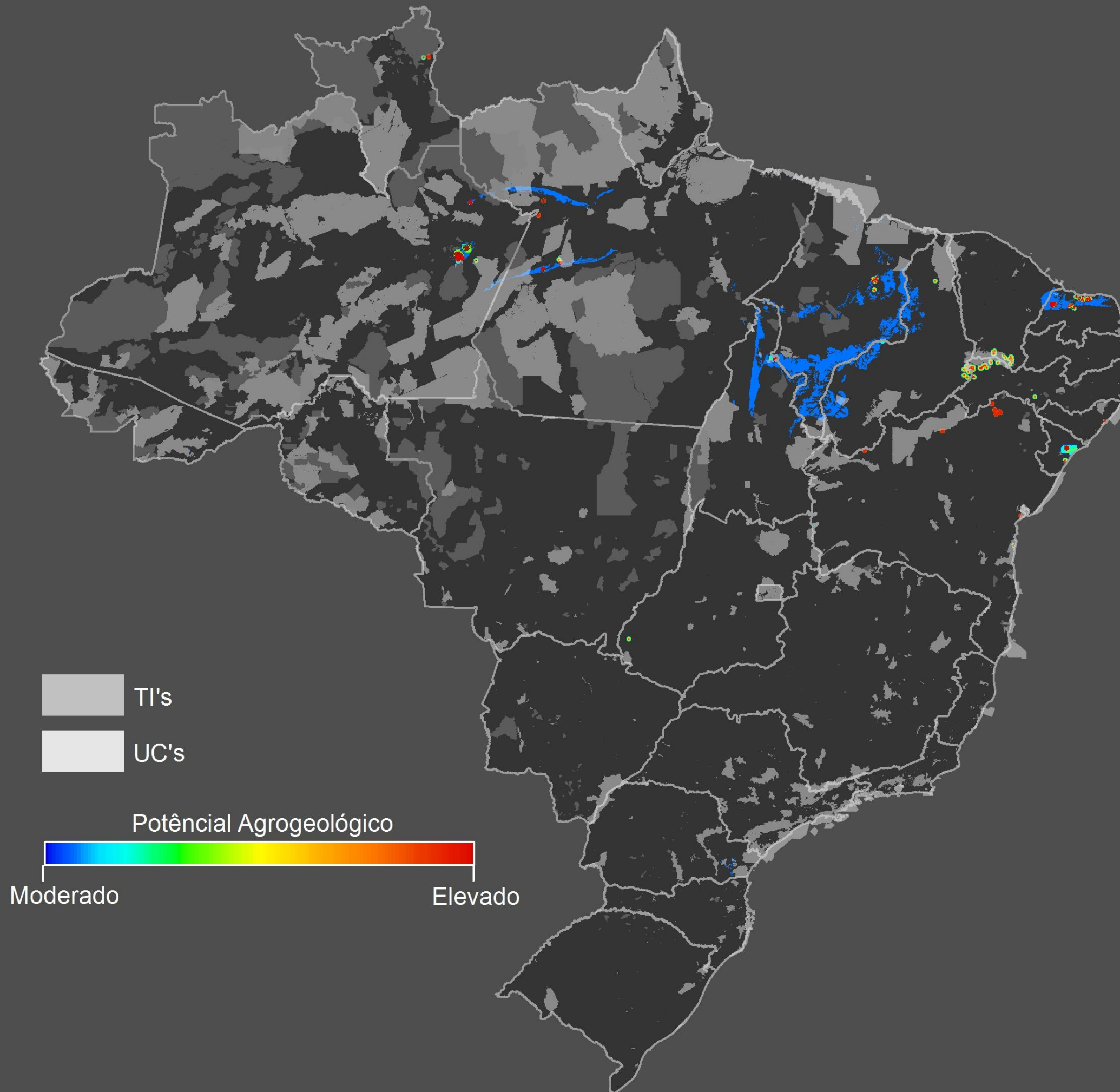
## Integração





# Cloretos/ Sulfatos

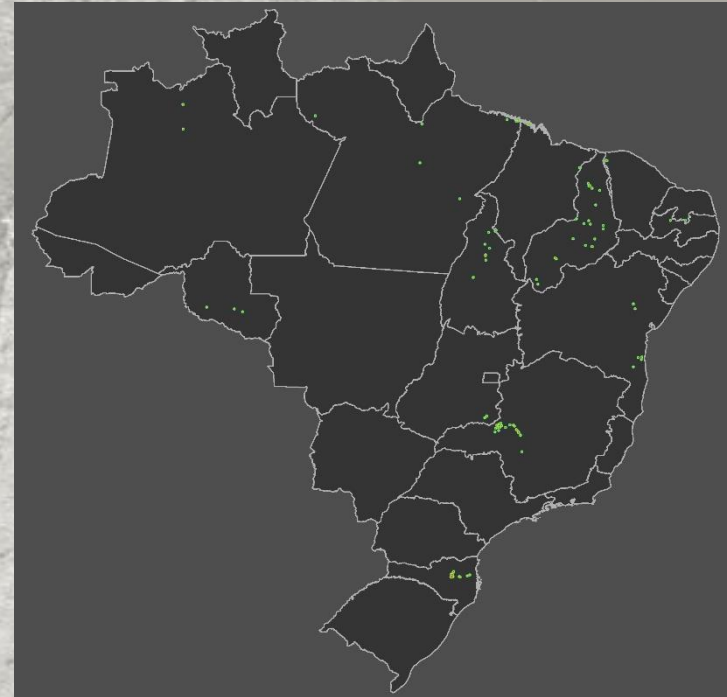
## Integração





# Fosfato Sedimentar

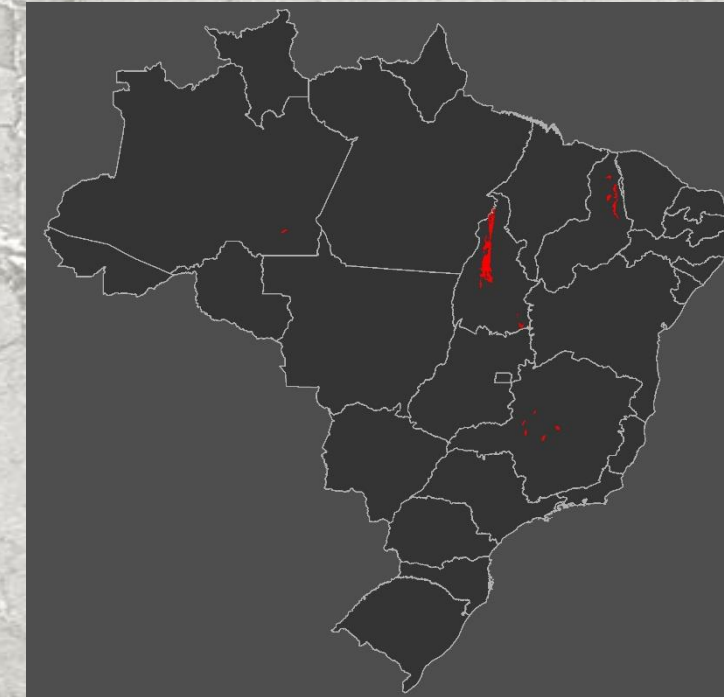
$P_2O_5 \geq 2\%$



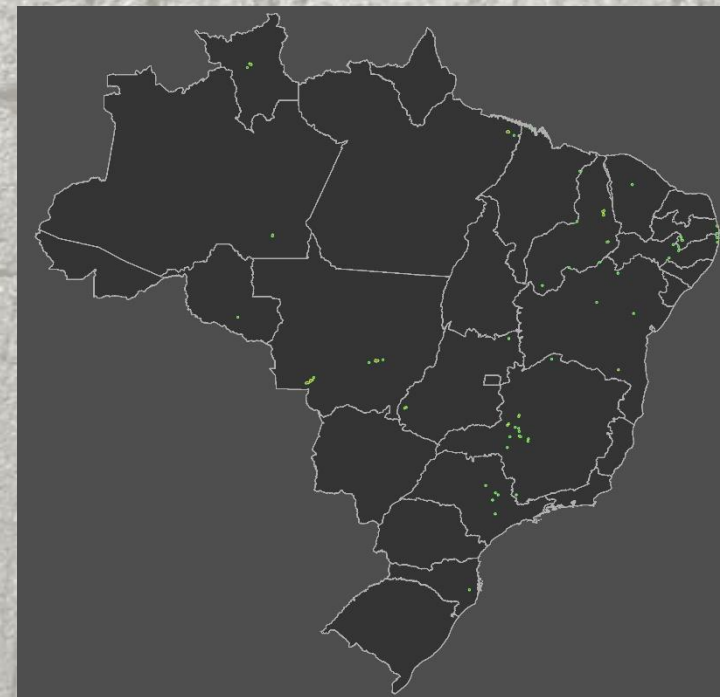
Lito. Fosfato Sed.



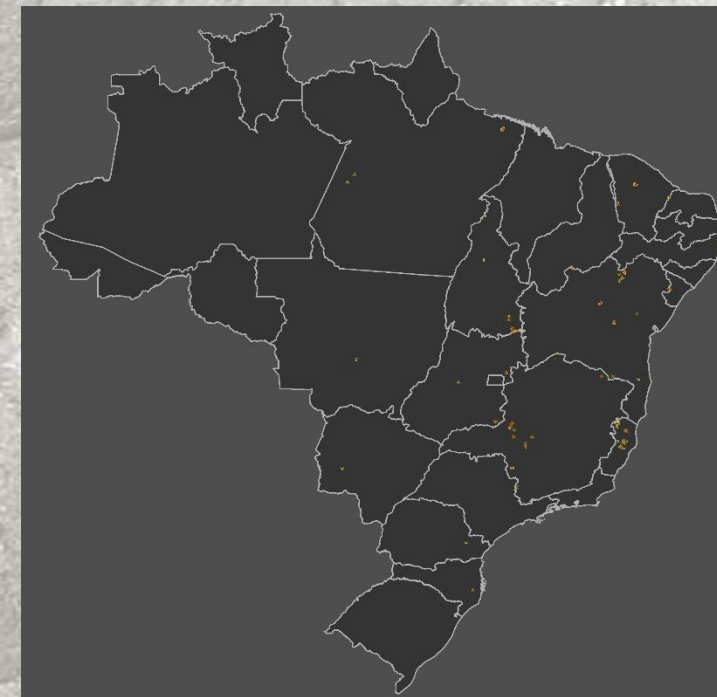
ARIM Fosf. Sed.



Rec. Min. Fosf. Sed.

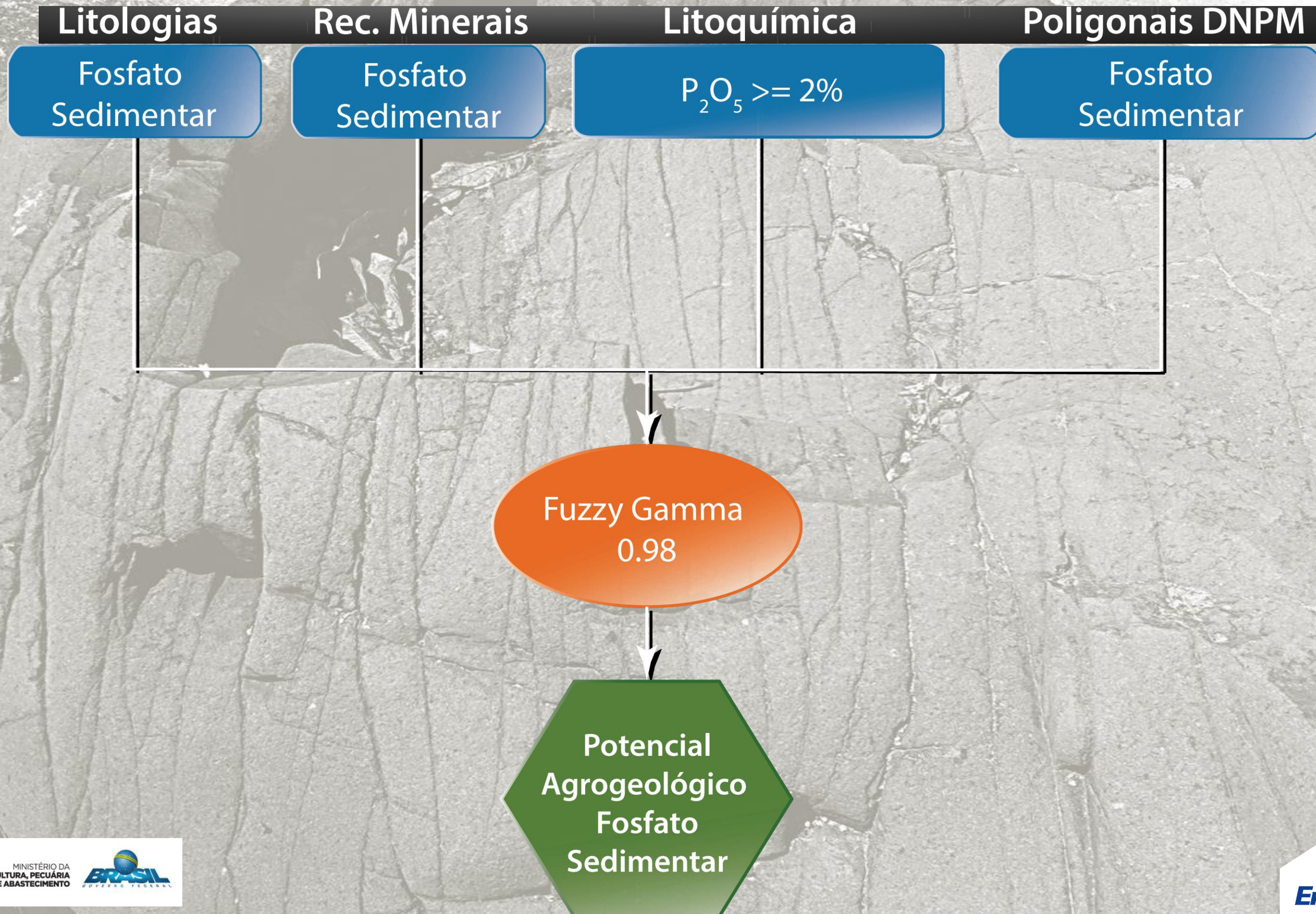


DNPM Fosfato Sed.





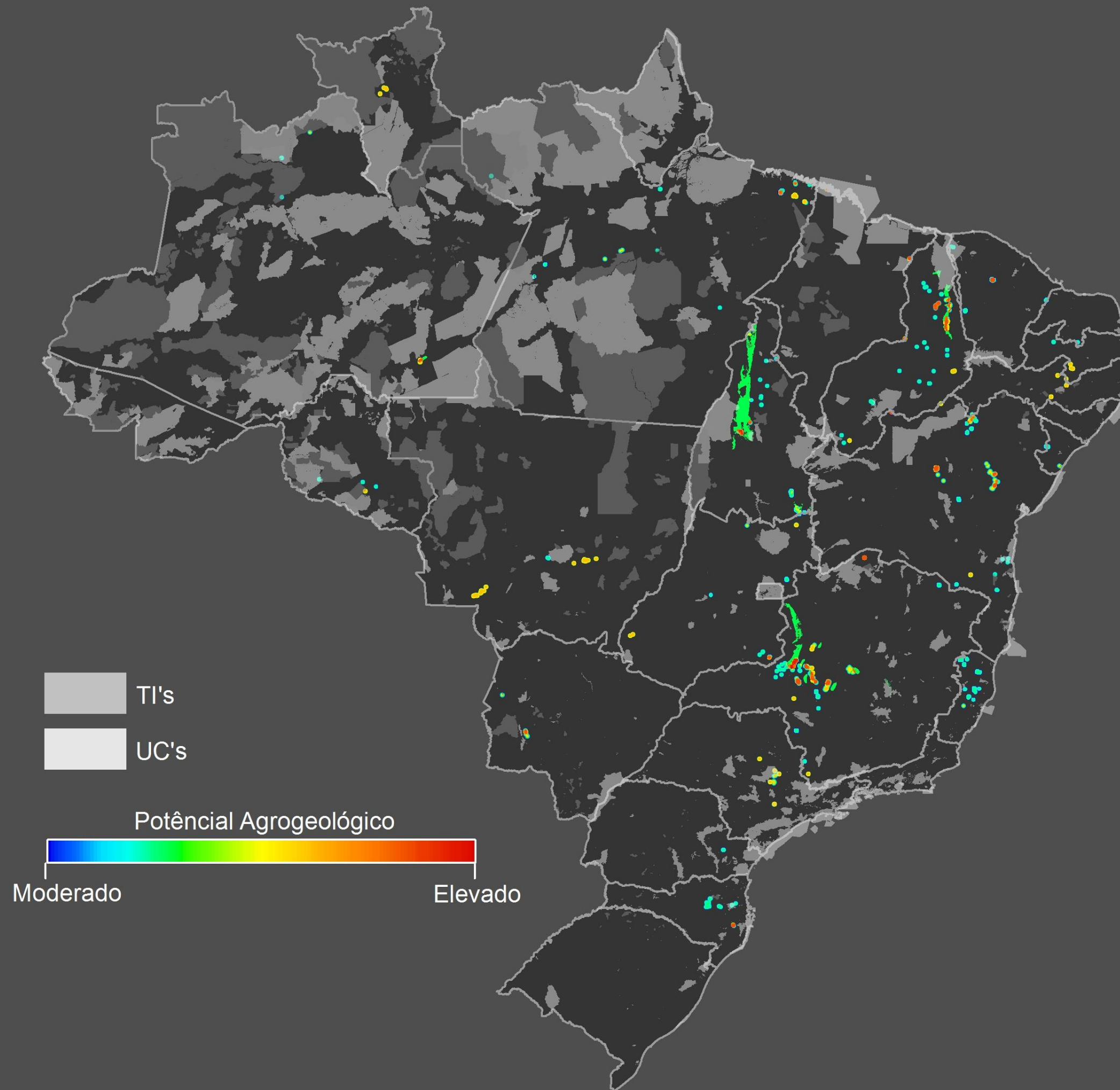
# Fosfato Sedimentar





# Fosfato Sedimentar

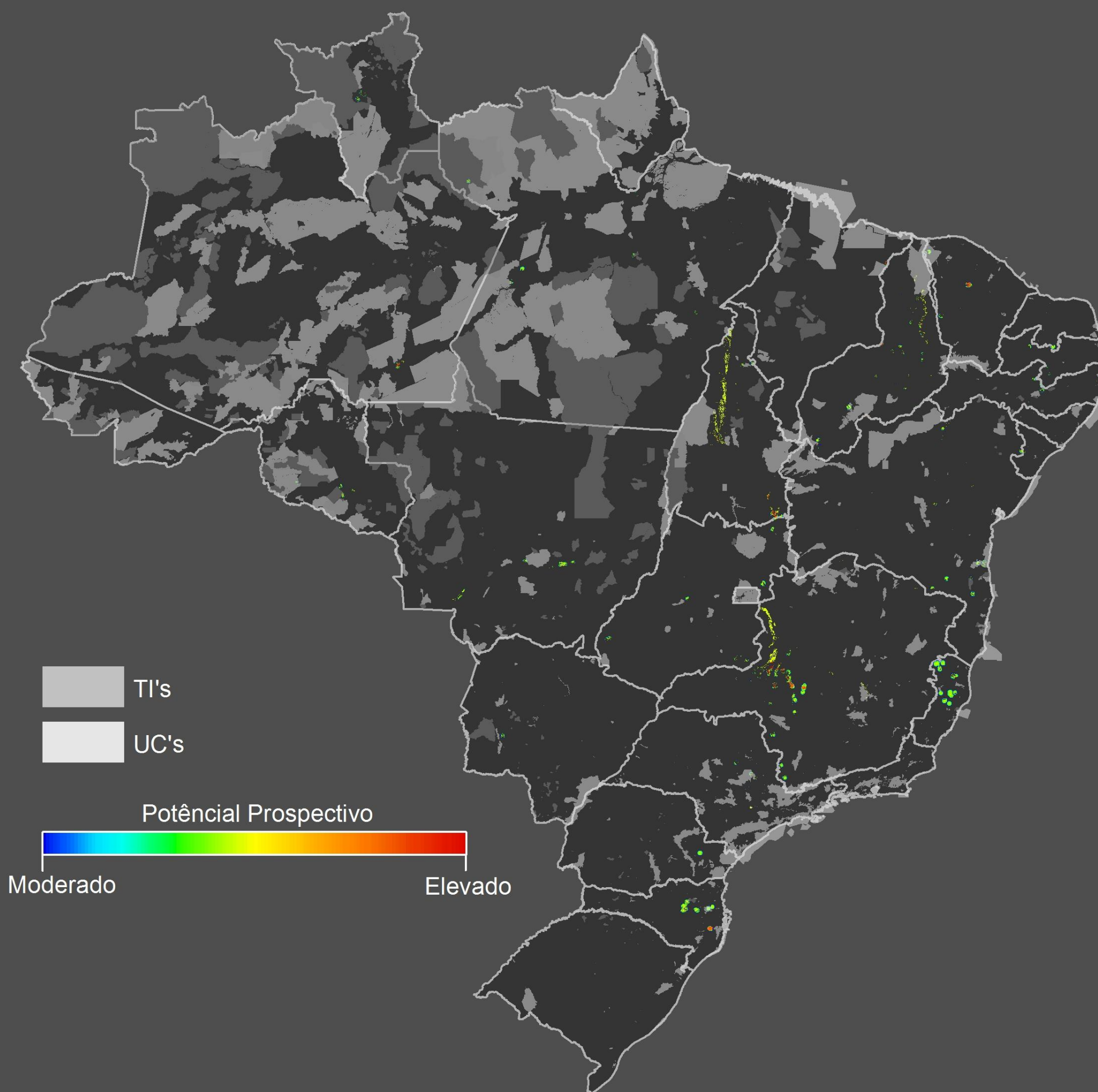
## Integração





# Fosfato Sedimentar

## Integração





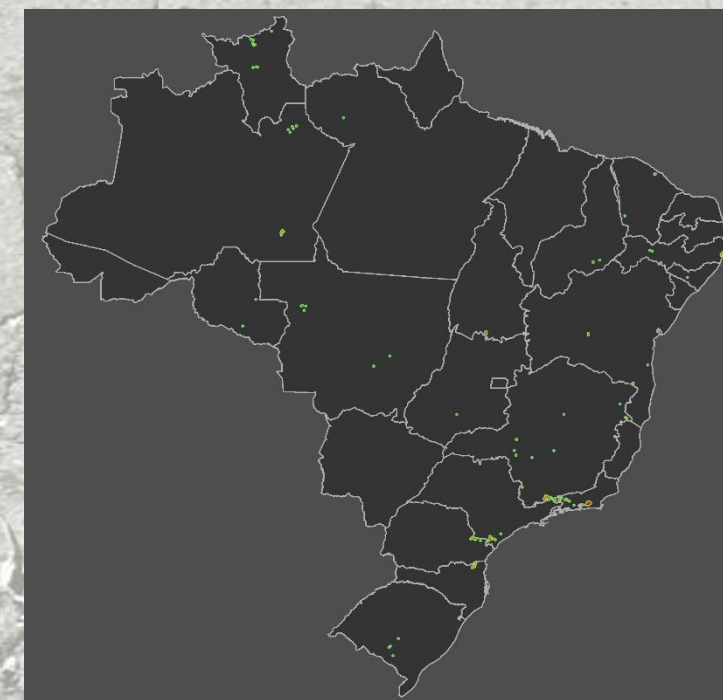
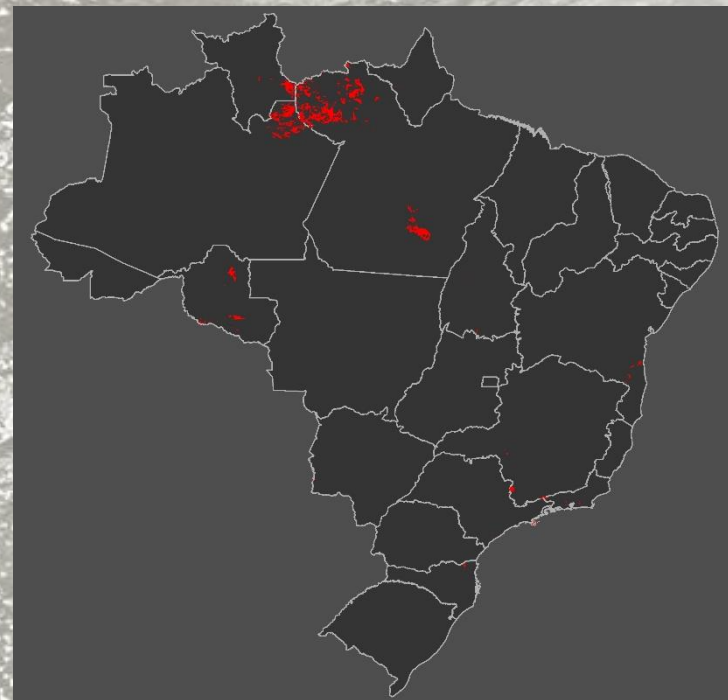
# Fosfato Ígneo

Lito. Alcalina

$P_2O_5 \geq 2\%$

Aflo. Foscorito

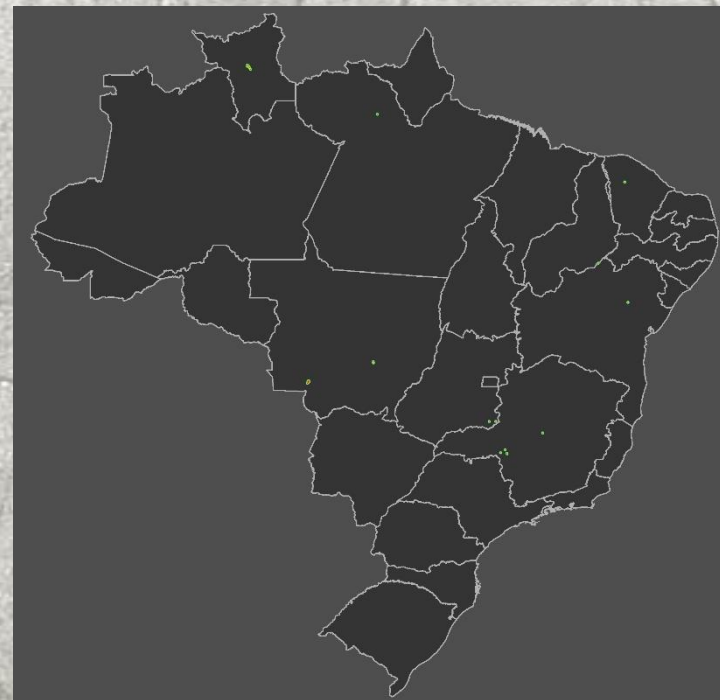
Aflo. Alcalina



ARIM Fos. Sil.

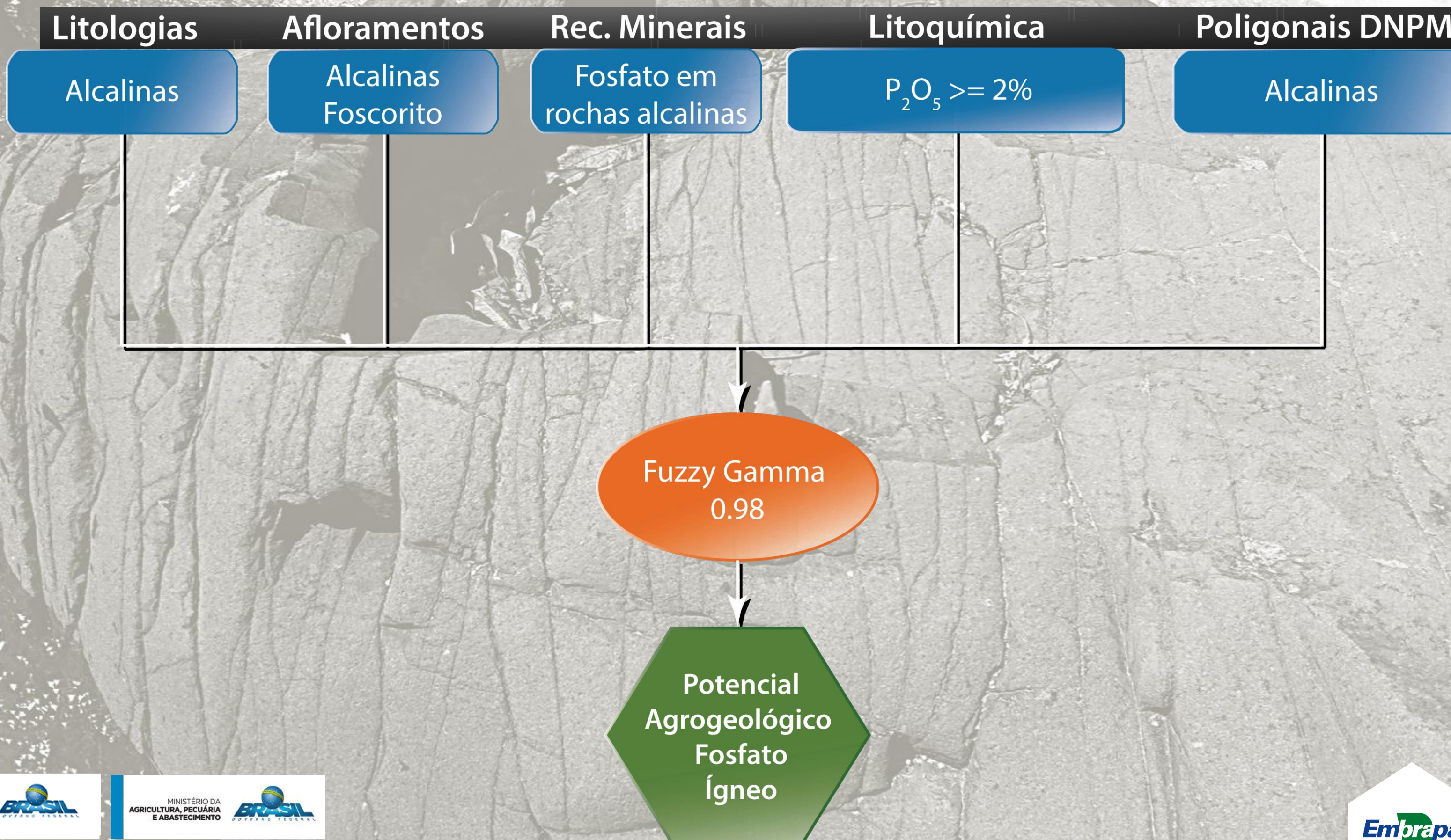
Rec. Min. Fos. Sil.

DNPM Alcalina





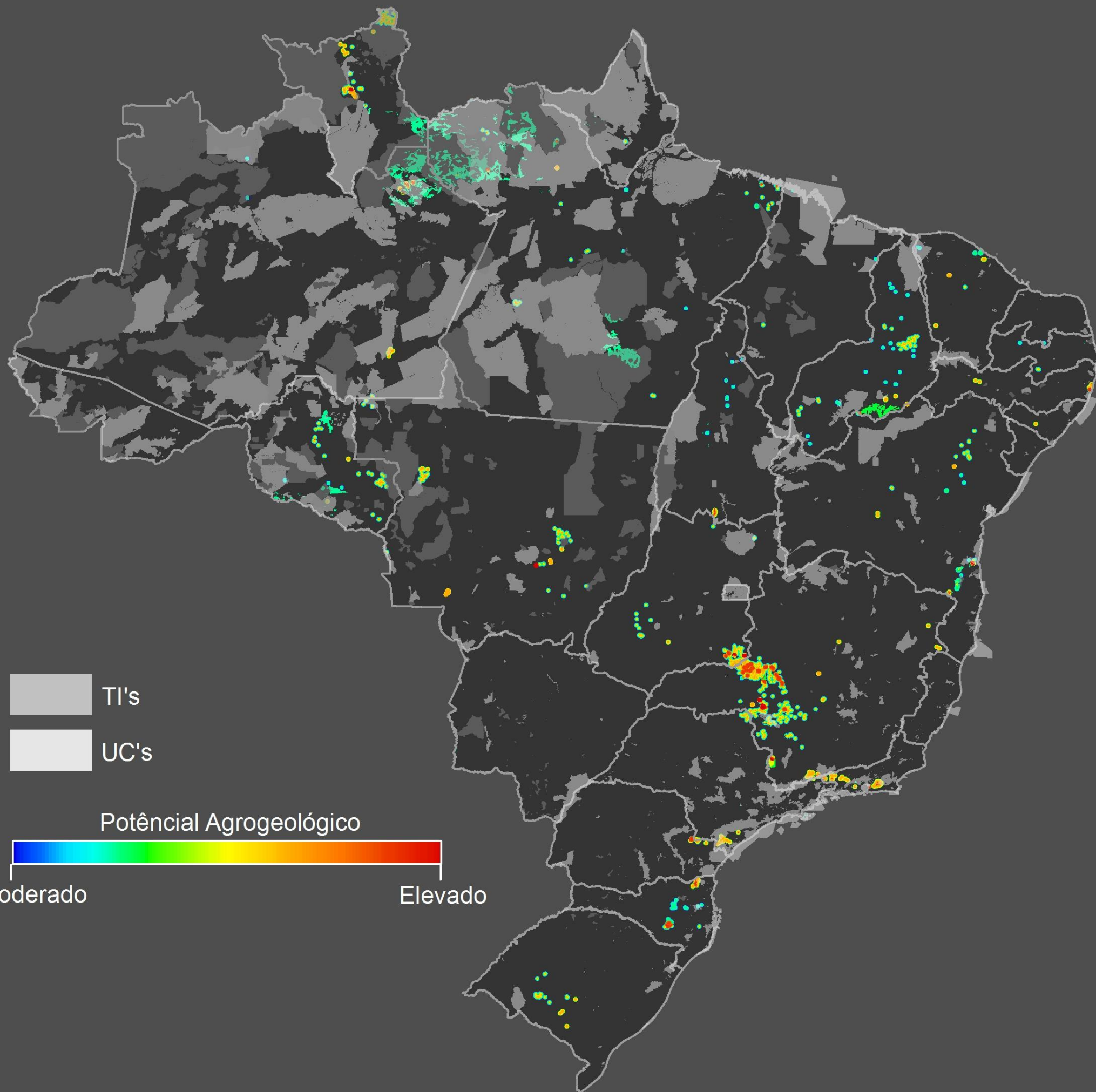
# Fosfato Ígneo





# Fosfato Ígneo

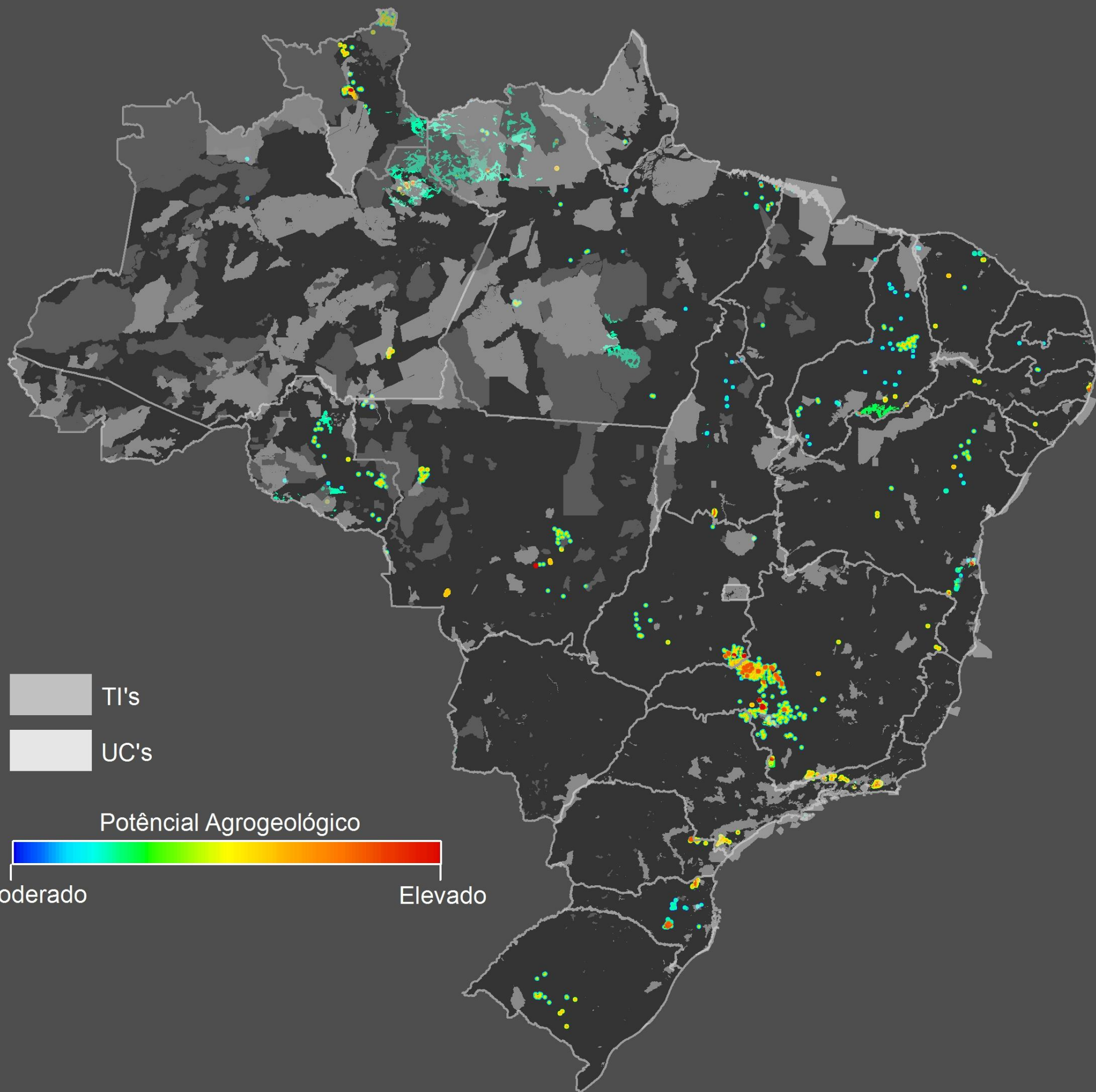
## Integração





# Fosfato – Ígneo

## Integração





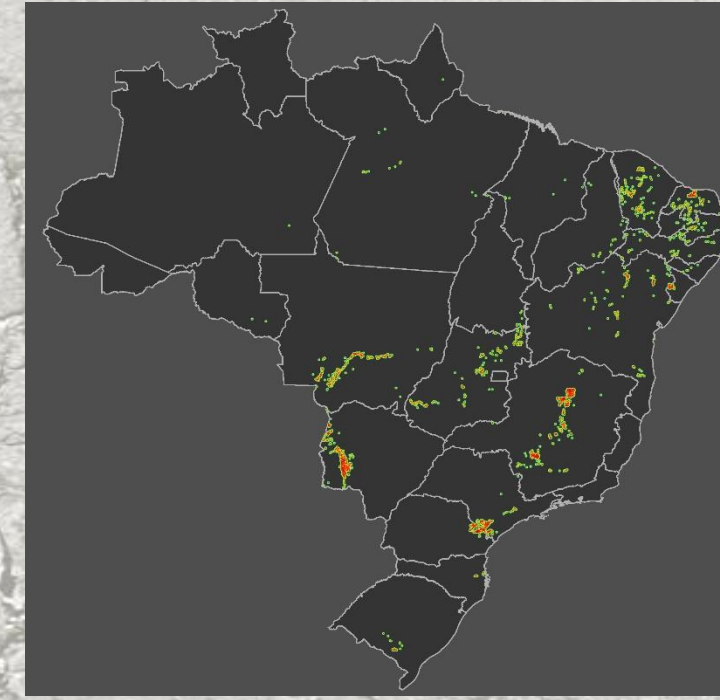
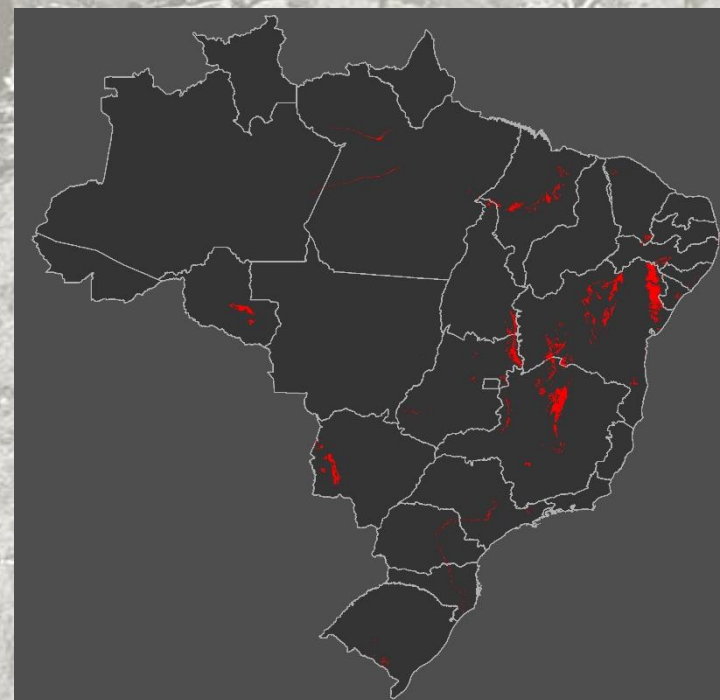
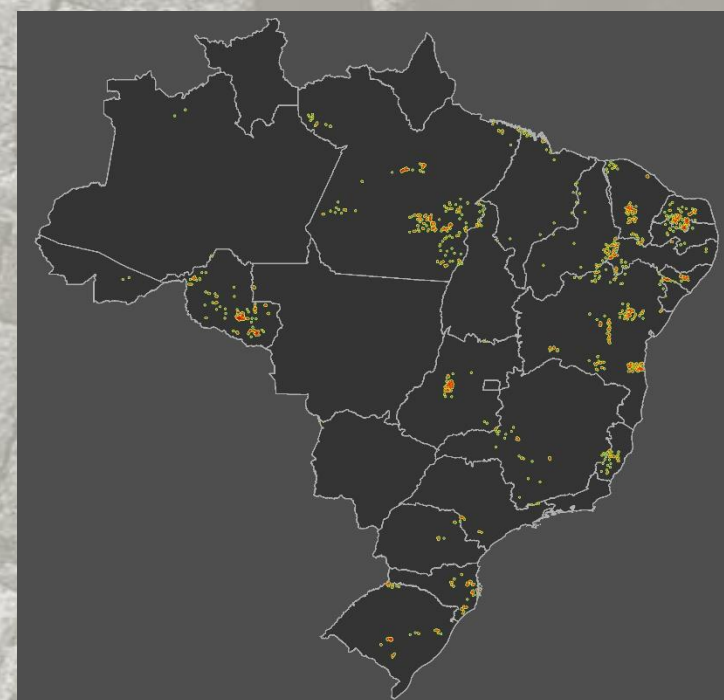
# Carbonatos

CaO  $\geq$  30%

CaO + MgO  $\geq$  20%

Lito. Calcários

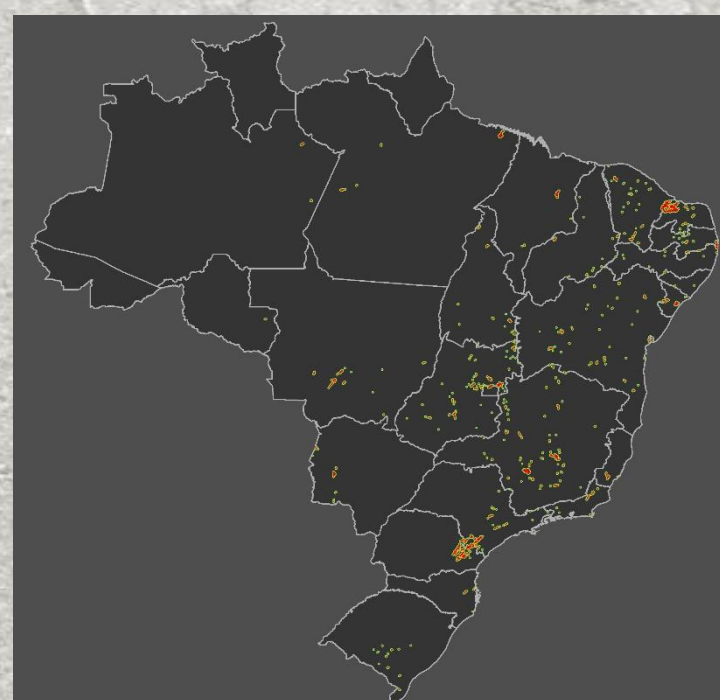
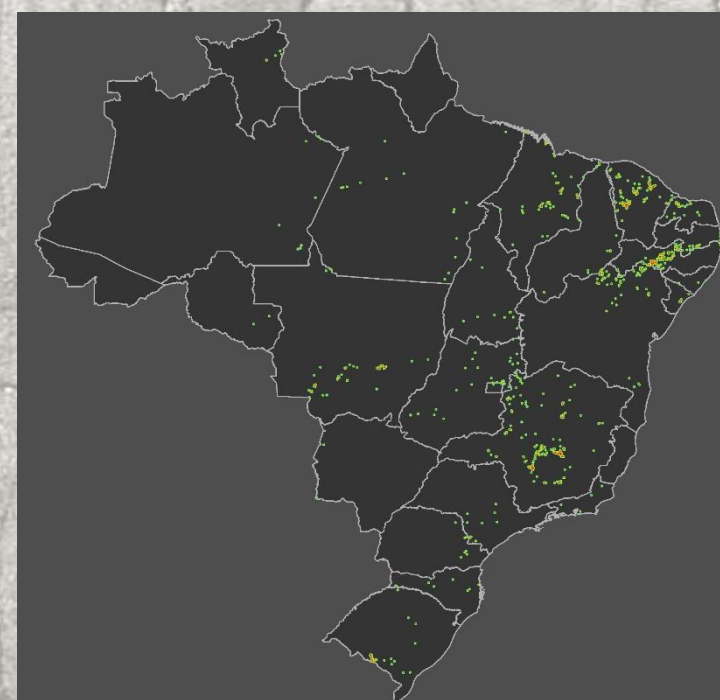
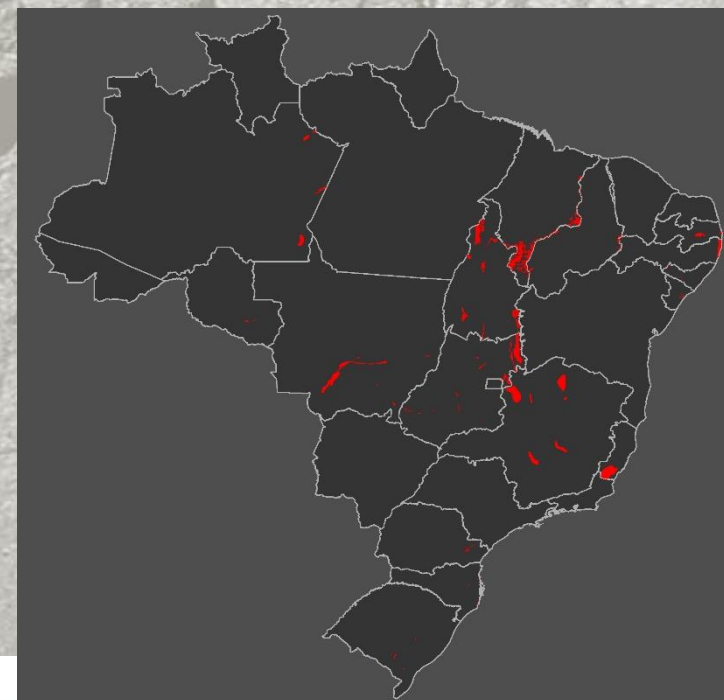
Aflo. Calcário



ARIM Calcário

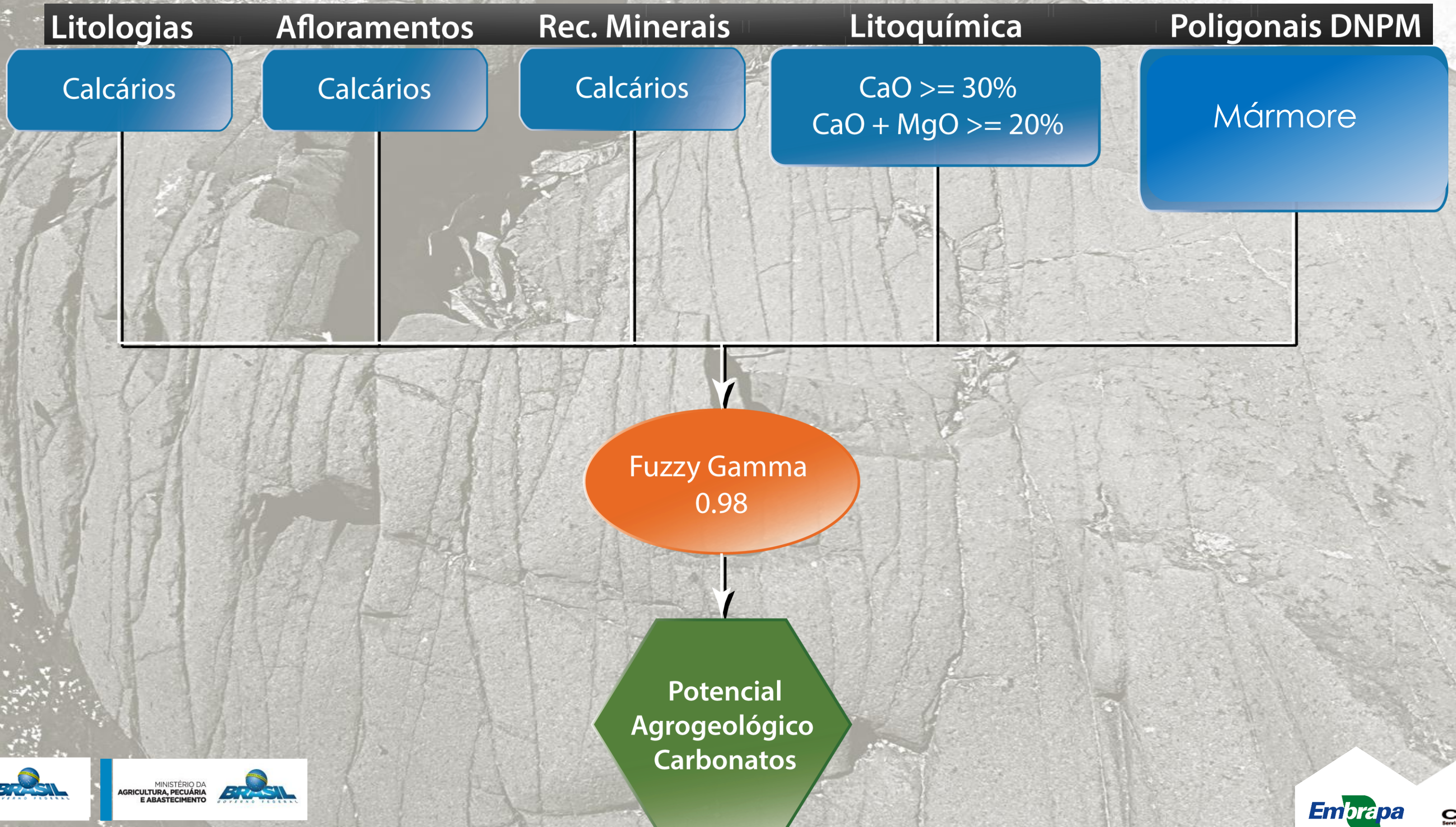
Rec. Min. Calcário

DNPM Calcário





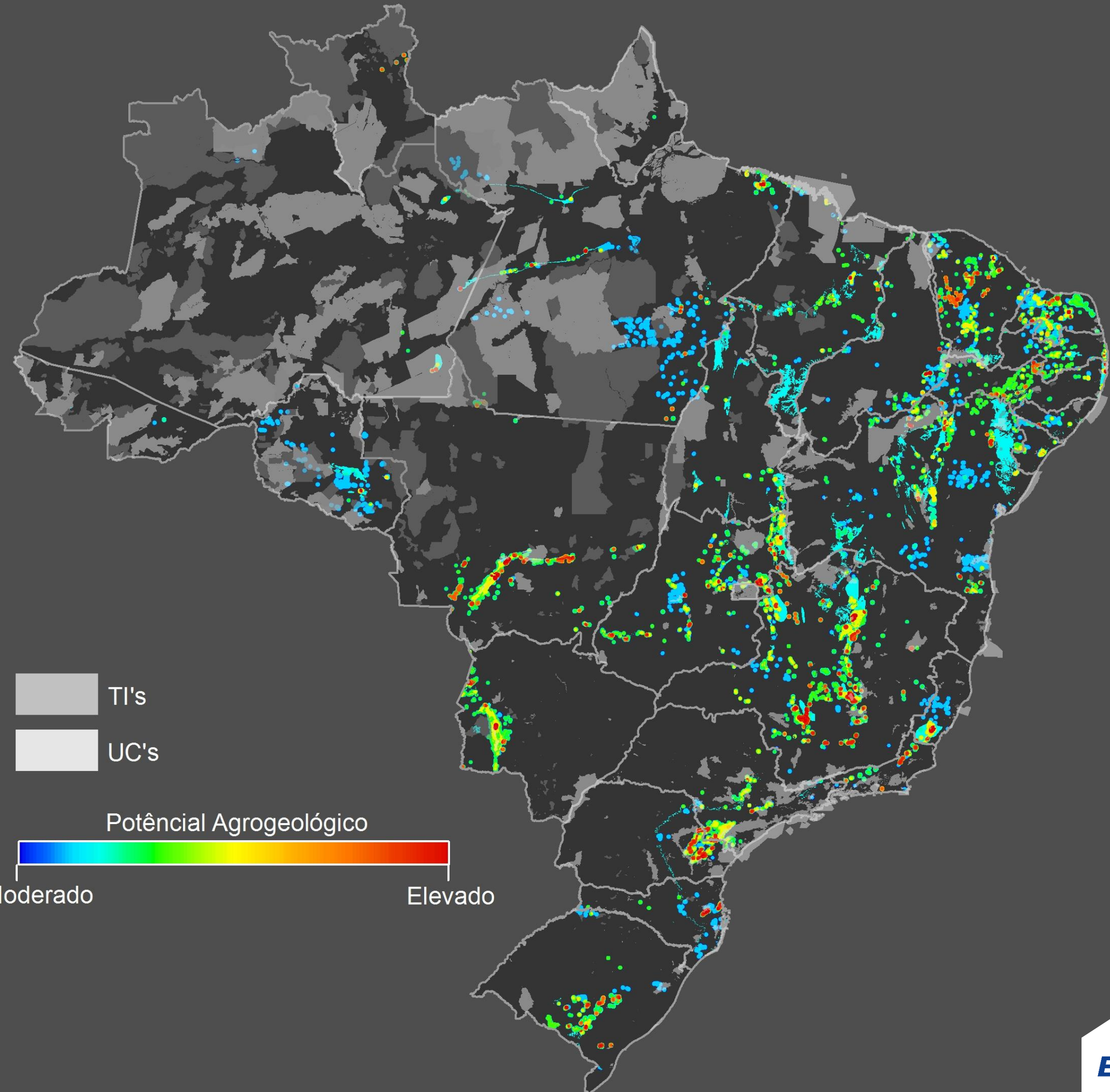
# Carbonatos





# Carbonatos

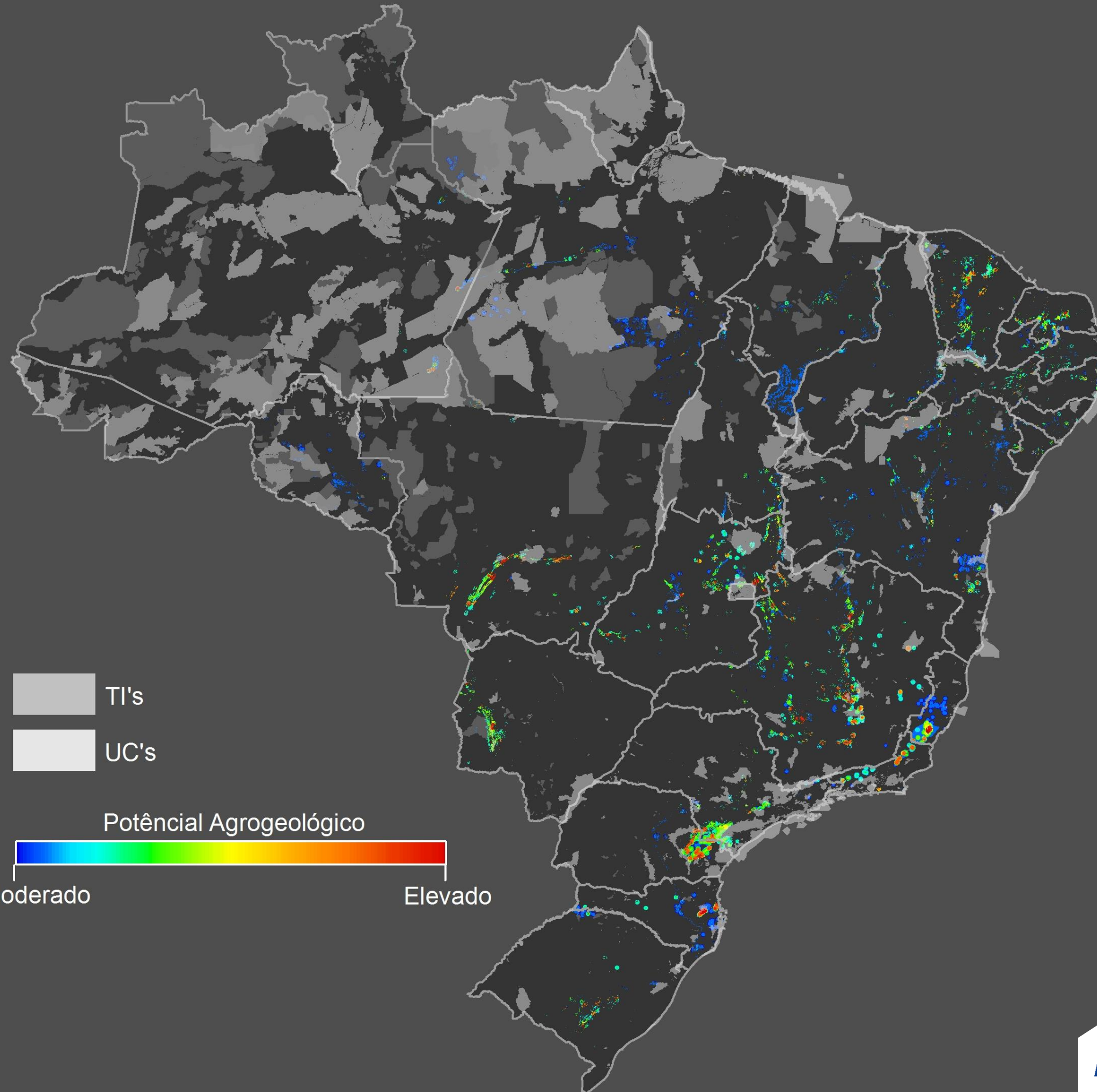
## Integração





# Carbonatos

## Integração Fuzzy Final





# Silicatos

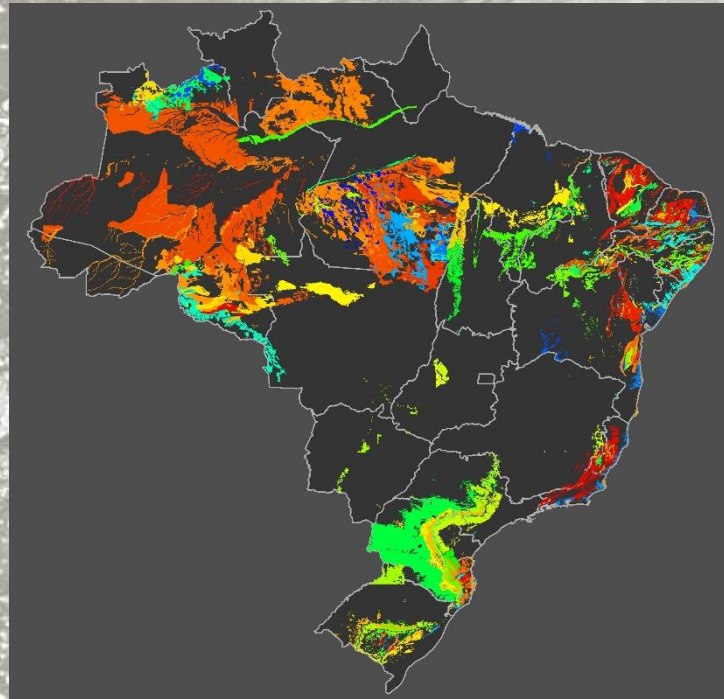
Subdivisão:

- Remineralizador de solos:
  - $K_2O \geq 1\%$
  - $K_2O + CaO + MgO \geq 9\%$
  - Quartzo  $\leq 25\%$
- Fertilizante K:
  - $K_2O \geq 4\%$
- Fertilizante Ca,Mg:
  - $CaO + MgO \geq 12\%$



# Remineralizadores

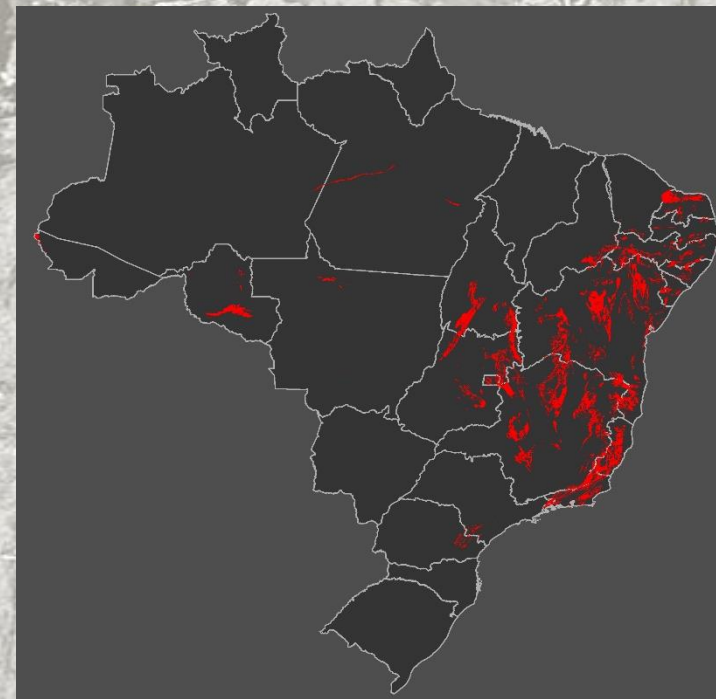
Lito. Remin.



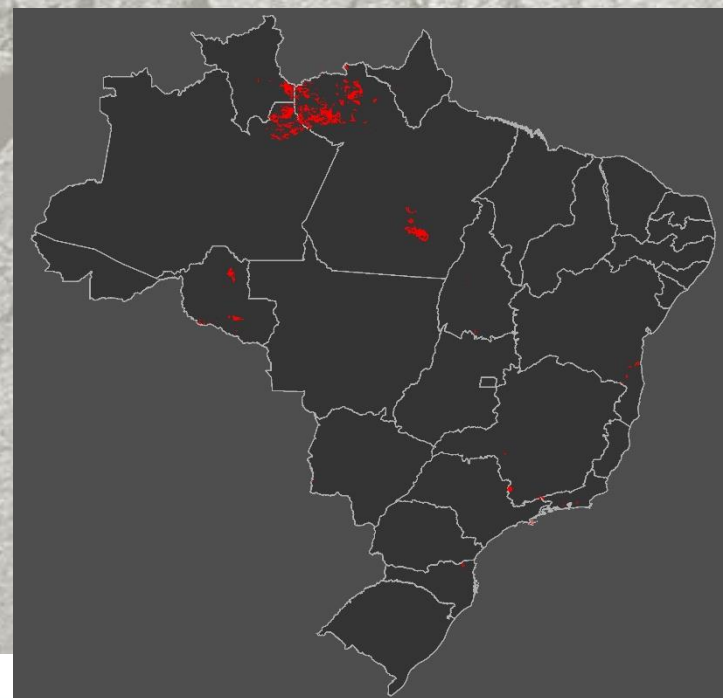
Lito Máficas/Ultra.



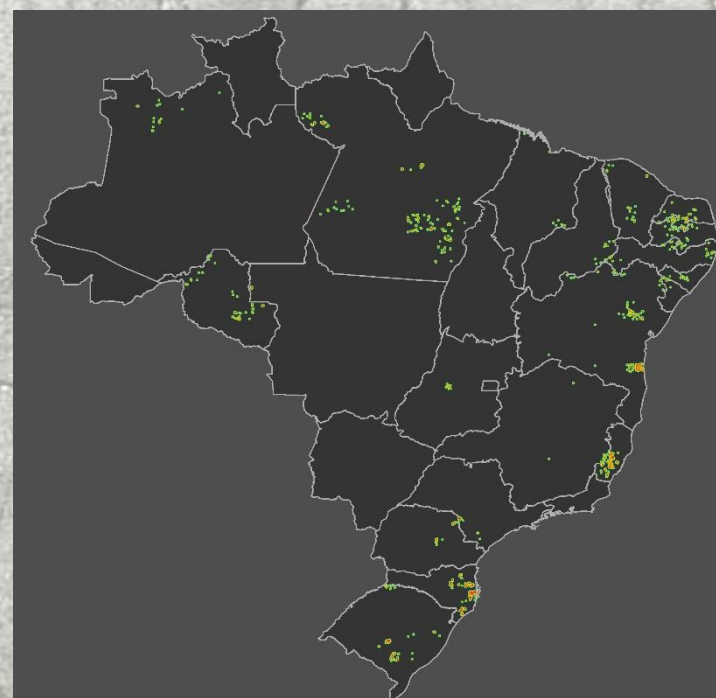
Lito Calcisilicaticas



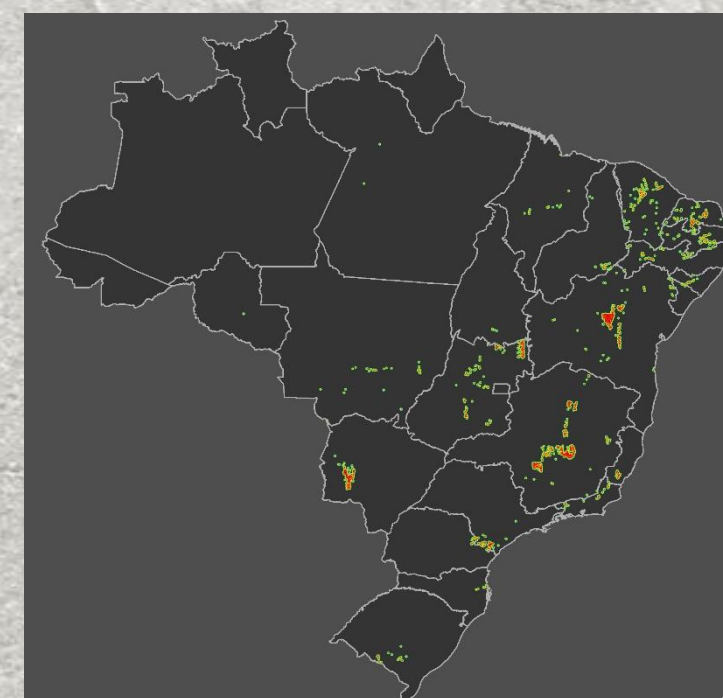
Lito Alcalinas



Geoq. Remin.



Aflo. Calcisili.



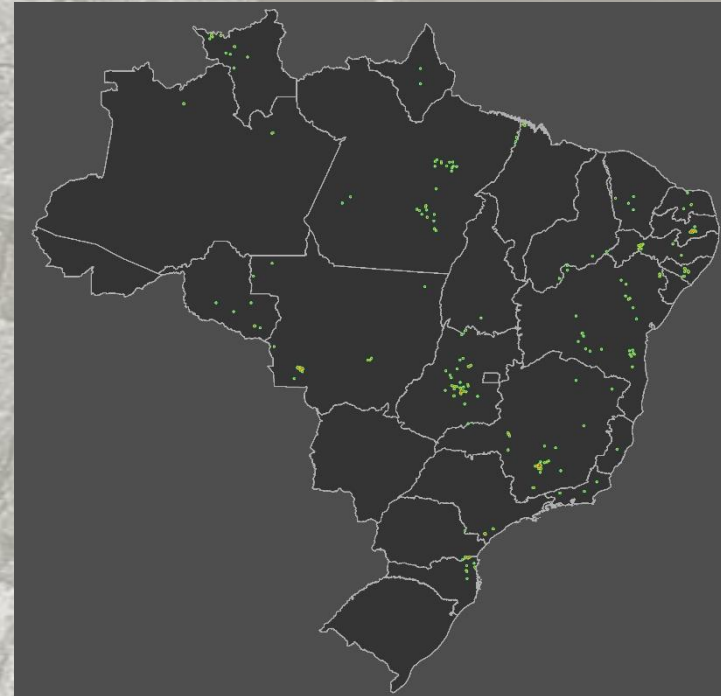


# Remineralizadores

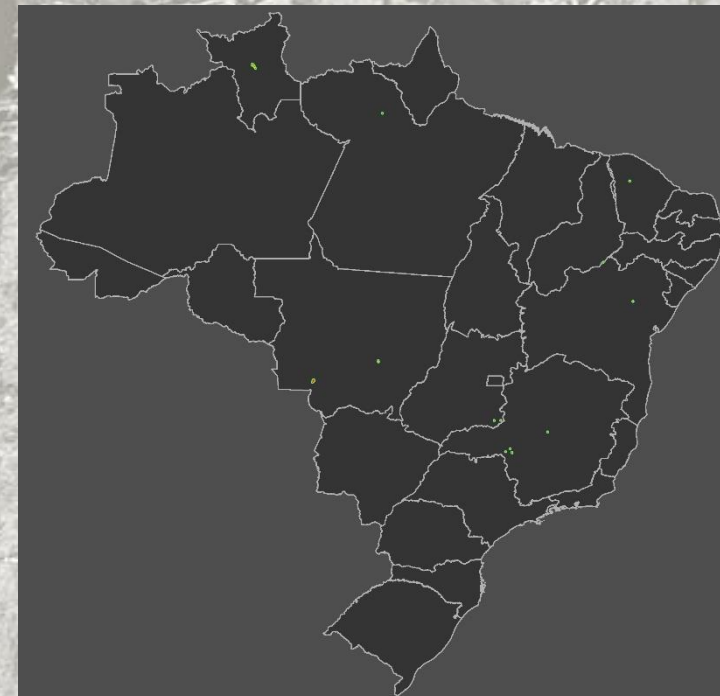
Aflo. Alcalinas



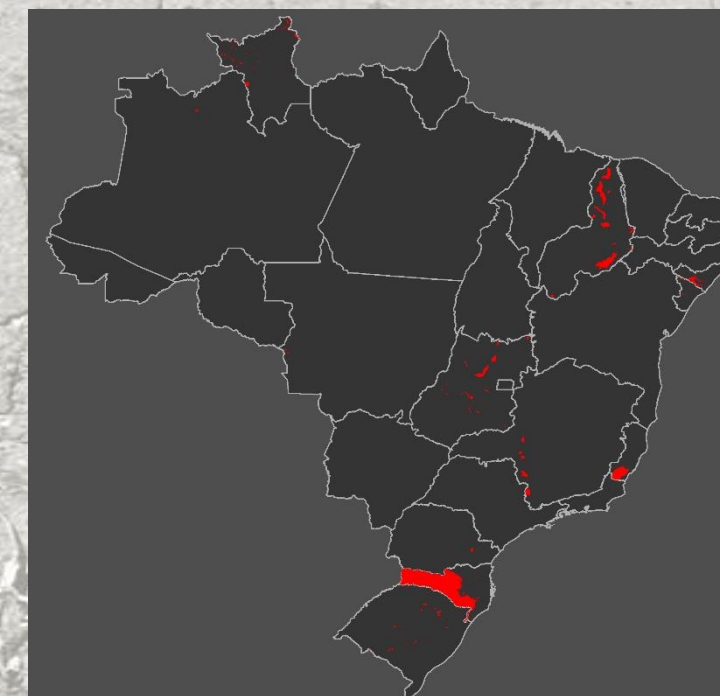
Aflo. Máficas/Ultr.



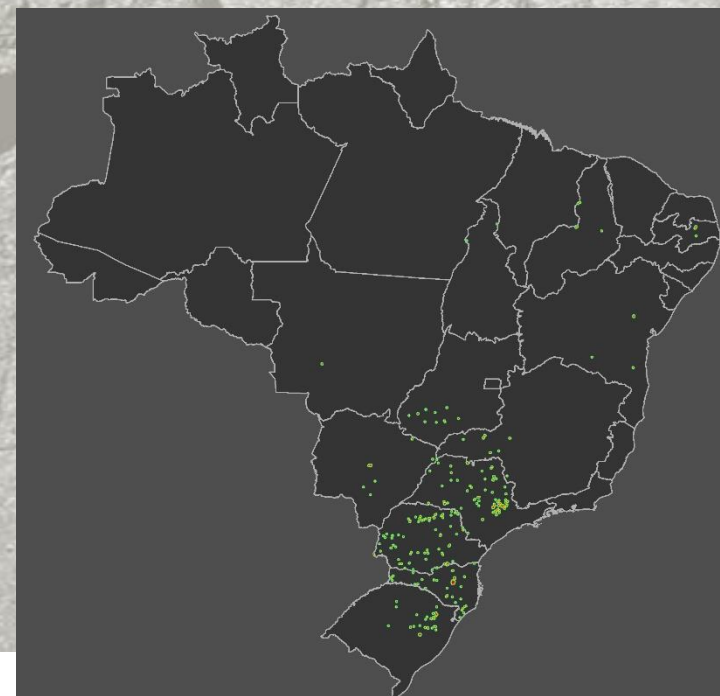
Rec. Min. Fosfato Sil.



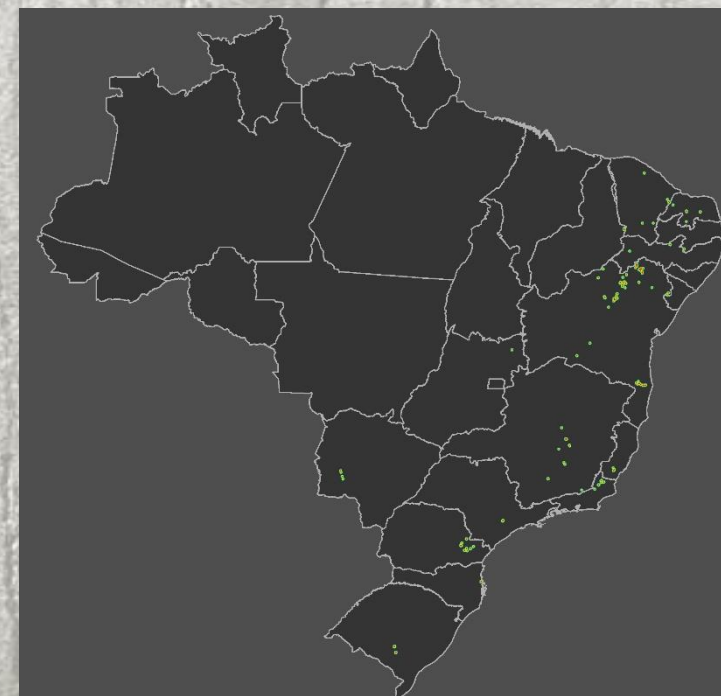
ARIM Reminer.



DNPM Máf./Ult.



DNPM Mármore

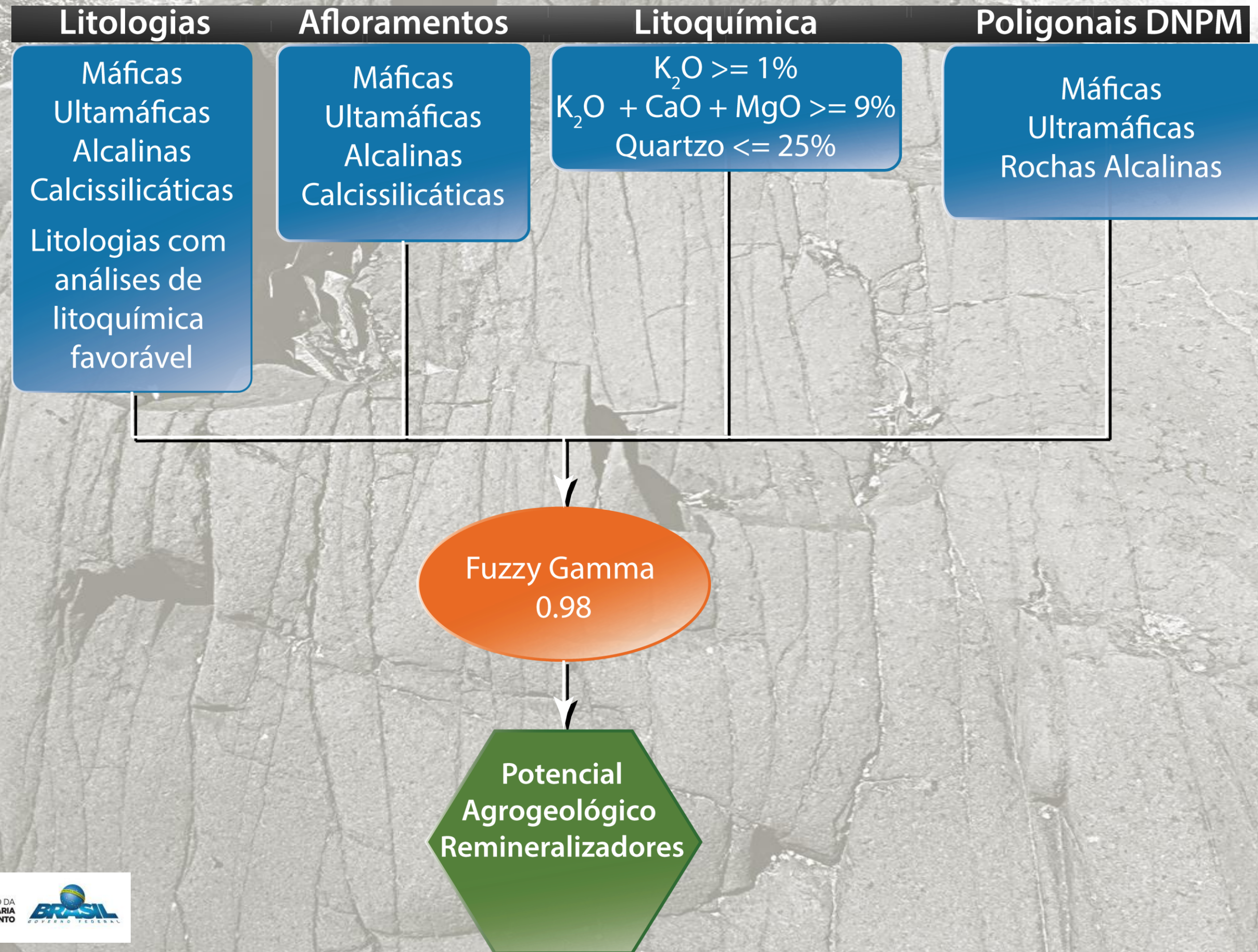


DNPM Alcalinas





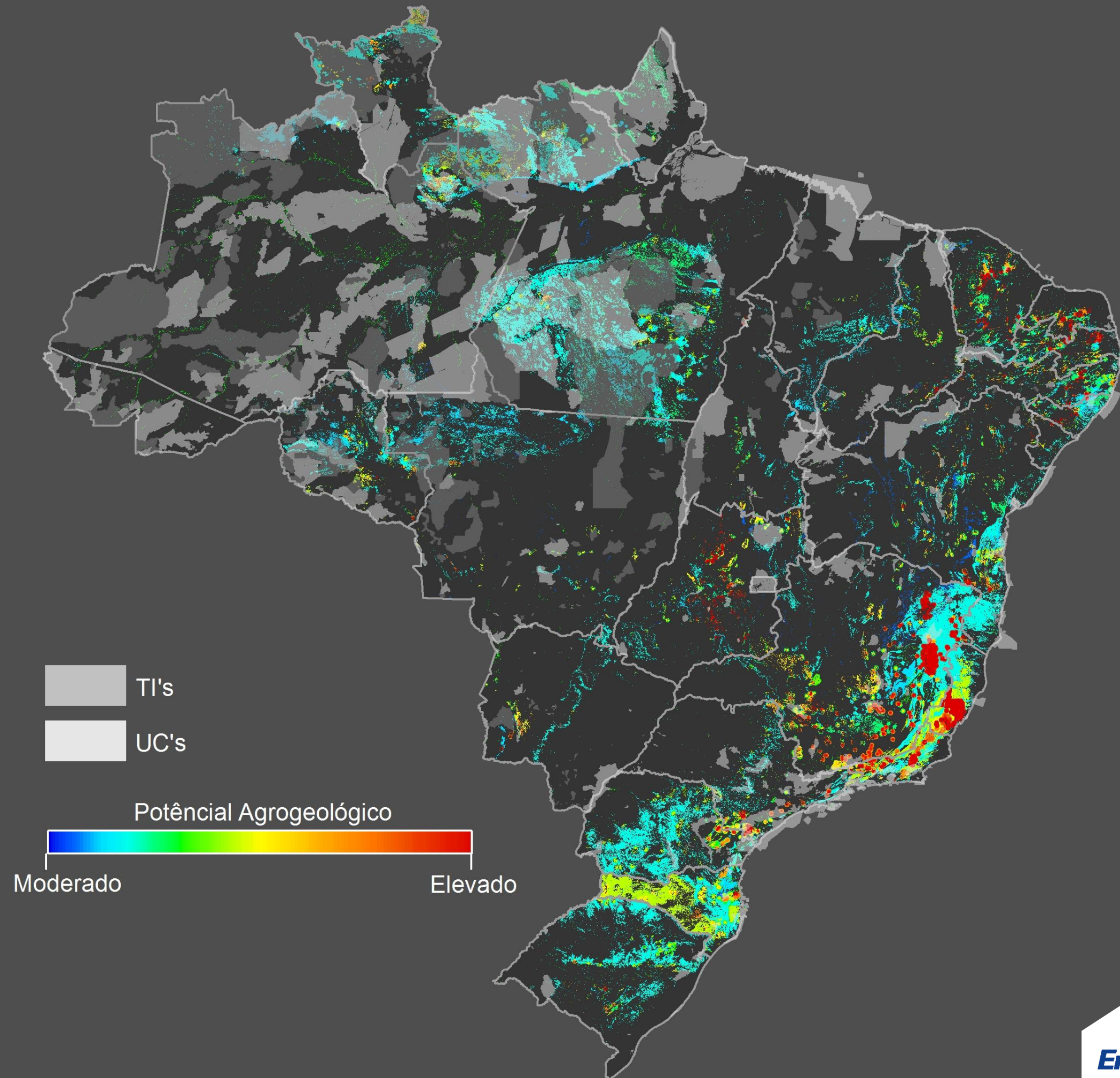
# Remineralizadores





# Remineralizadores

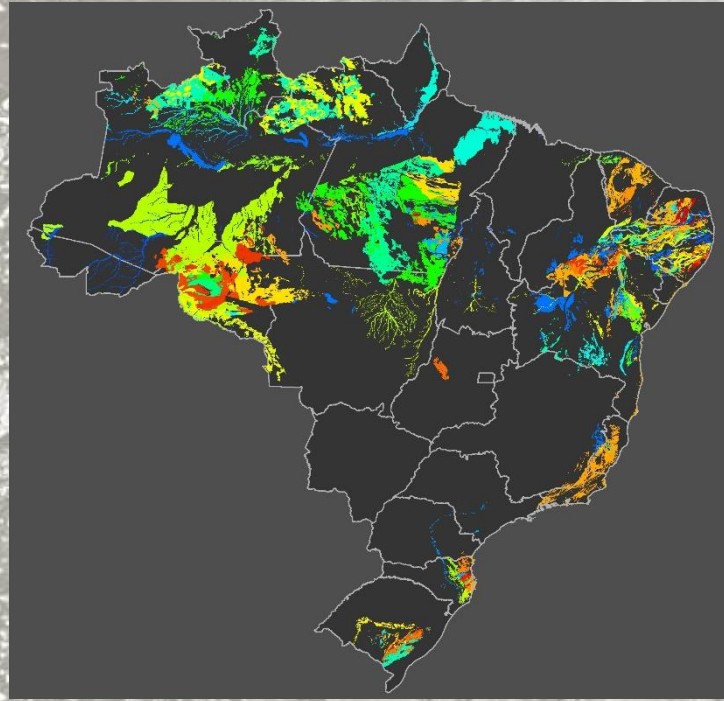
## Integração





# Fertilizante - K

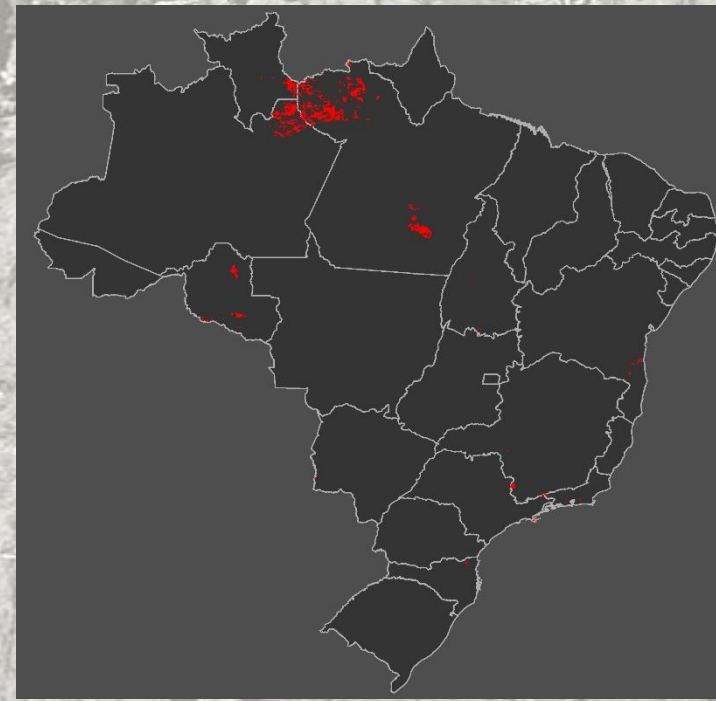
Lito. Fert. K



Lito Máficas/Ultra.



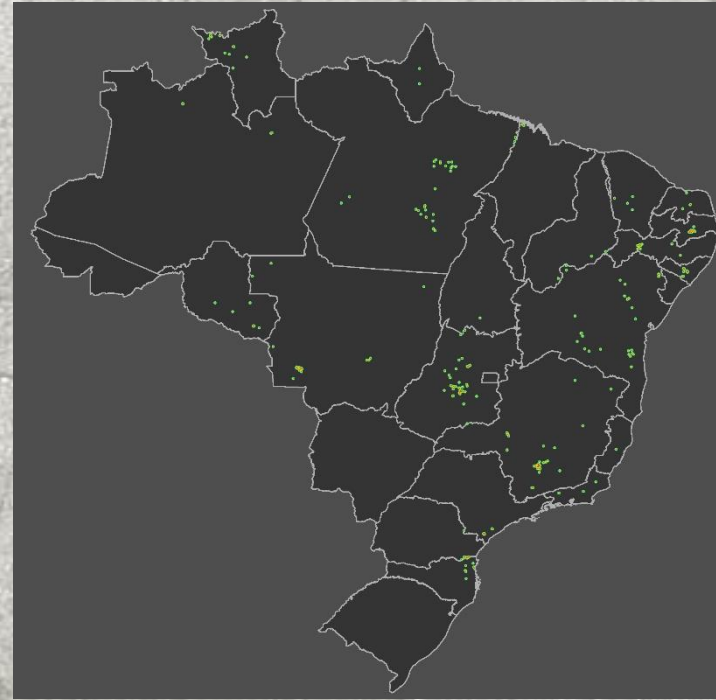
Lito Alcalinas



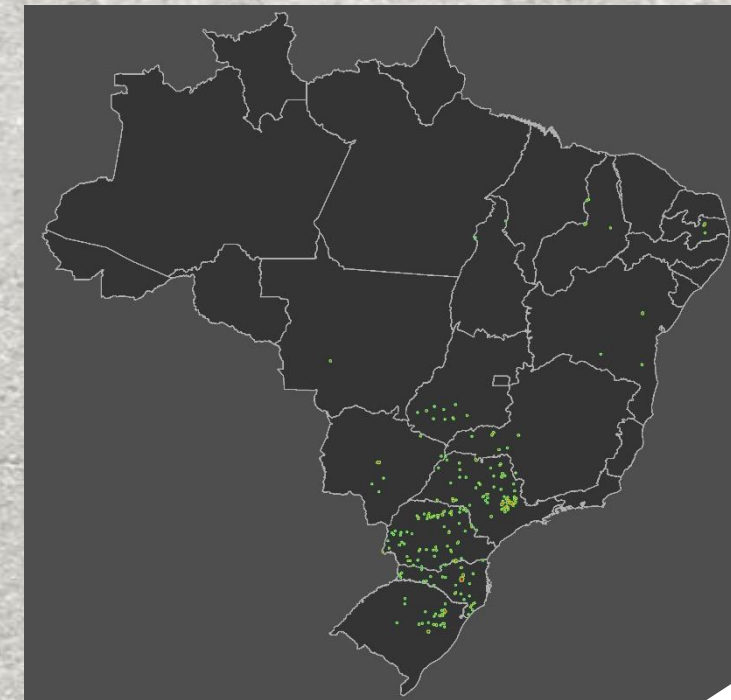
Aflo. Alcalinas



Aflo. Máf./Ult.



DNPM Máf./Ult.





# Fertilizante - K

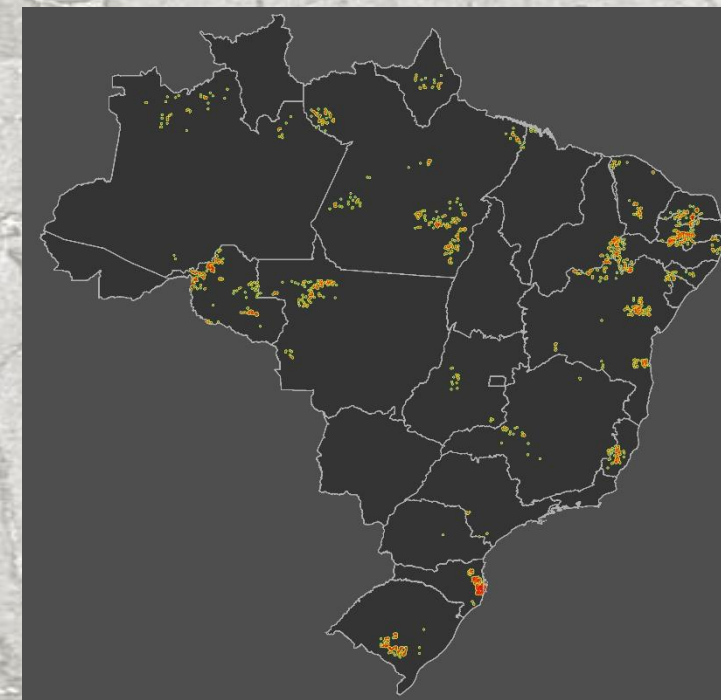
DNPM Rocha Pot.



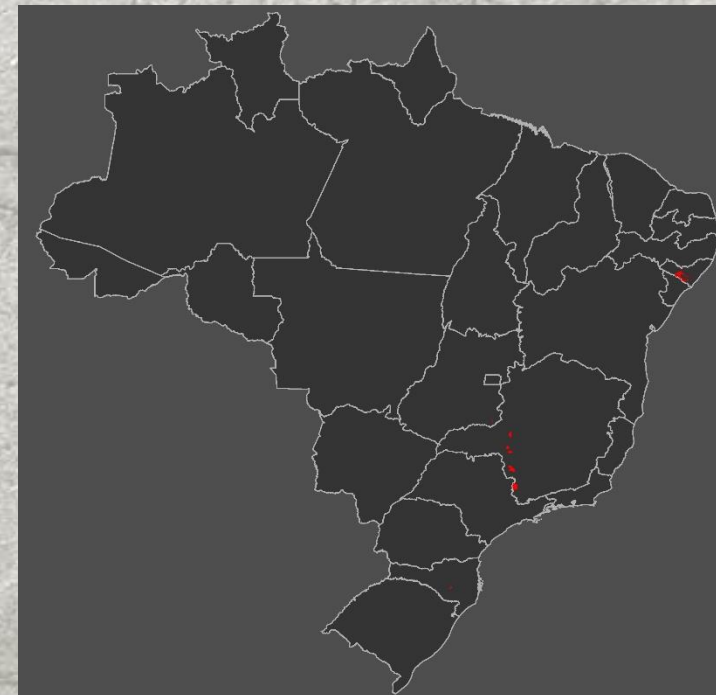
DNPM Alcalinas



$K_2O \geq 4\%$

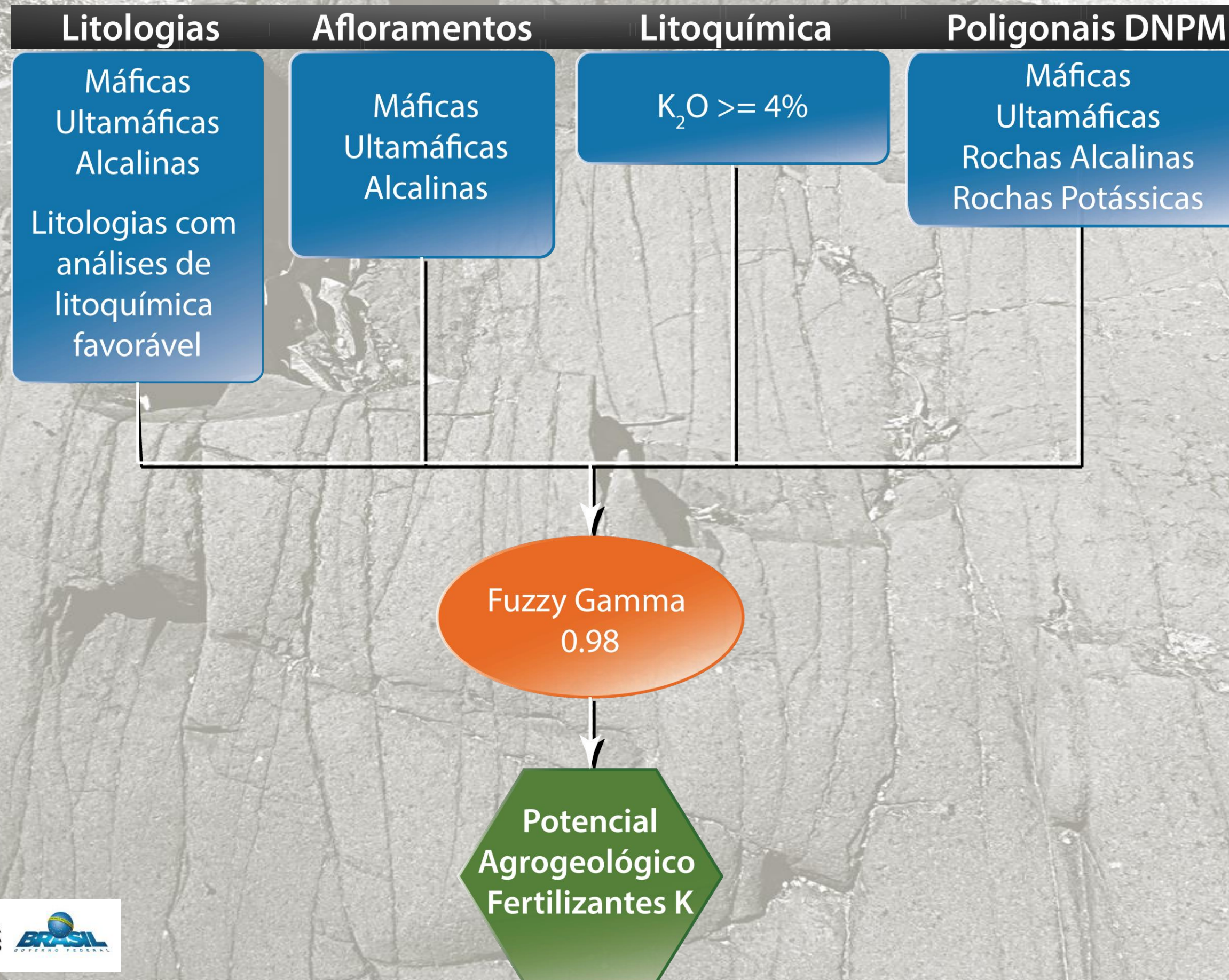


ARIM Fert. Macro. Nut. Essenciais





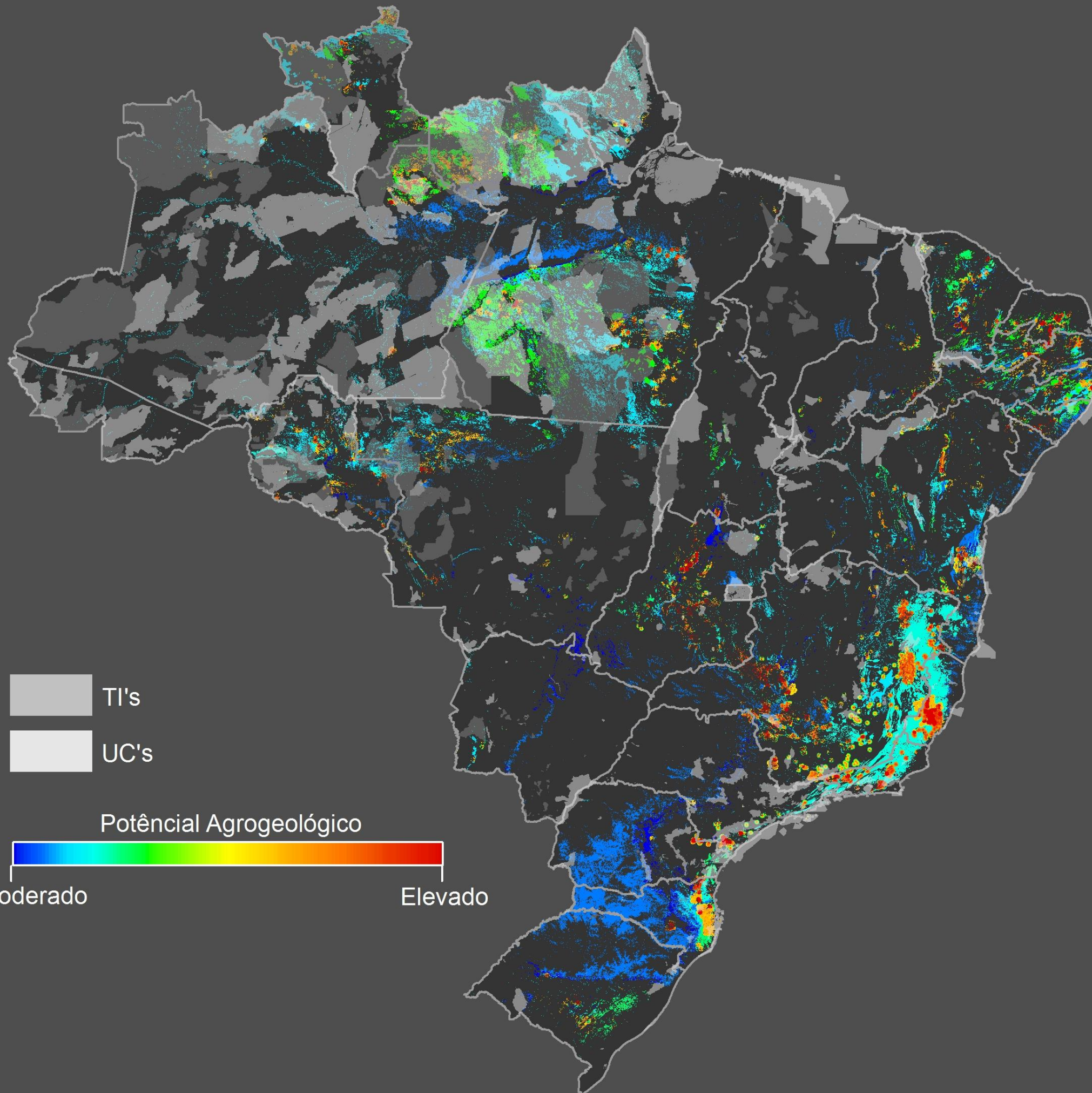
# Fertilizante - K





# Fertilizante - K

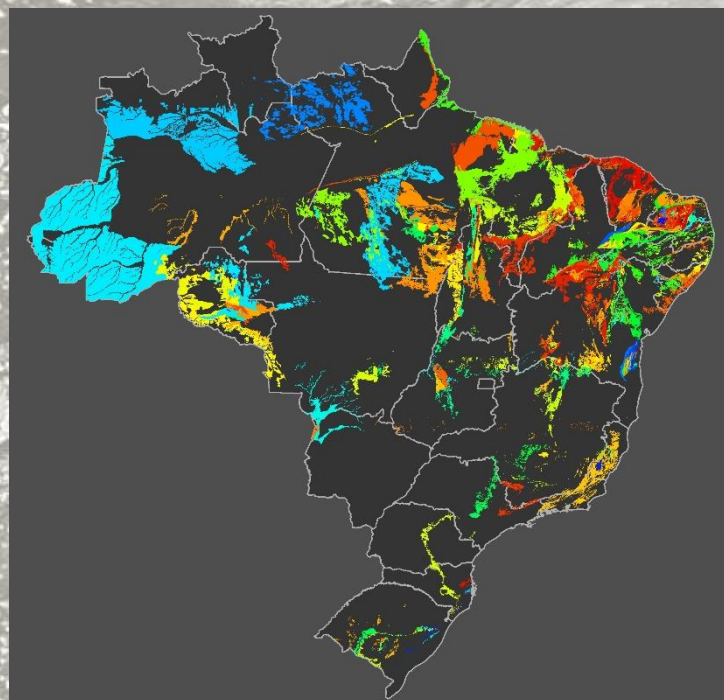
## Integração





# Fertilizante Macronutrientes Secundários – Ca, Mg

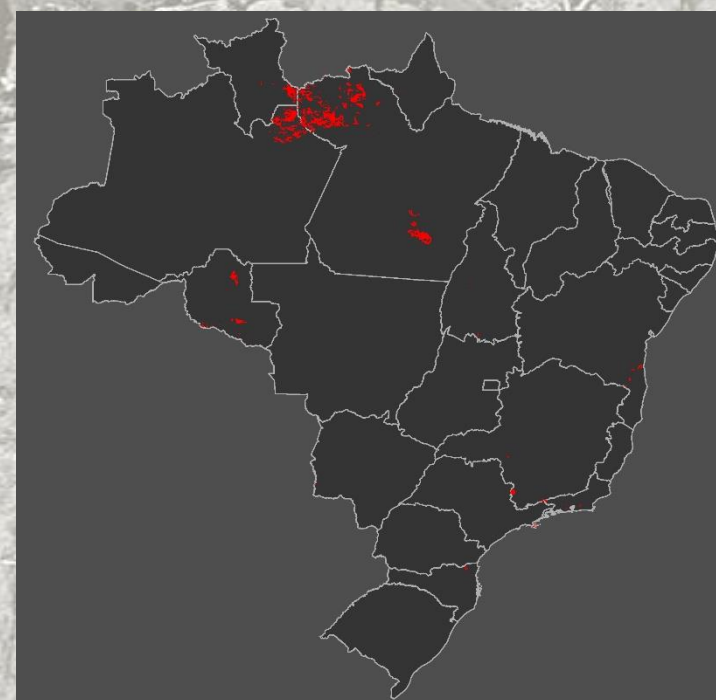
Lito. Fert. K



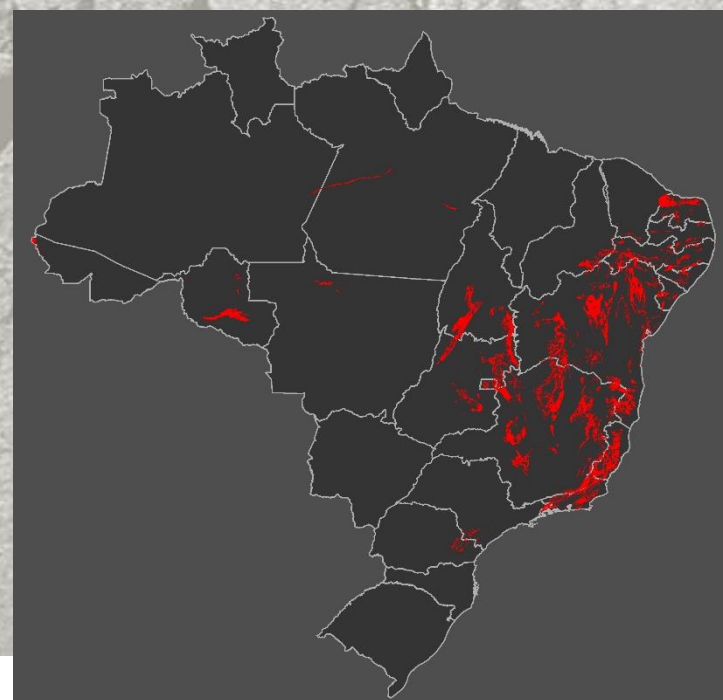
Lito Máficas/Ultra.



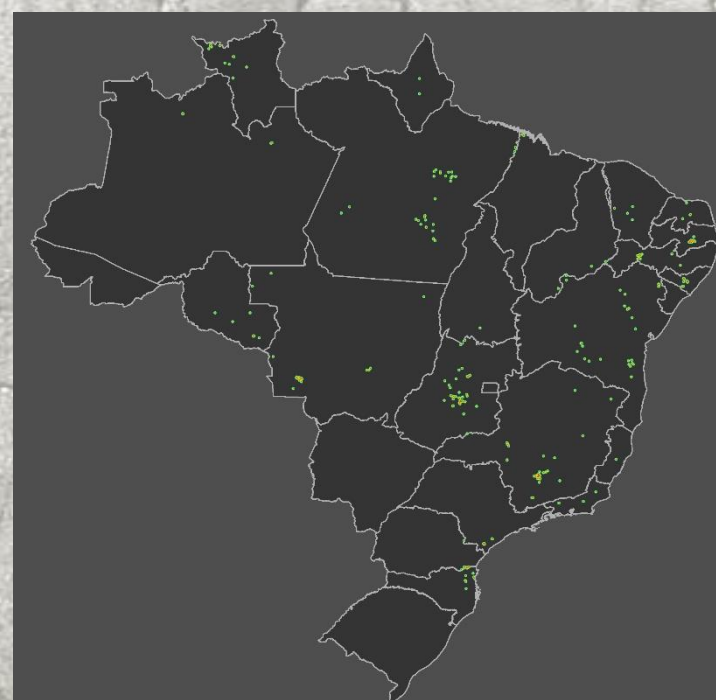
Lito Alcalinas



Lito Calcisil.



Aflo. Máf./Ult.



Aflo. Alcalina



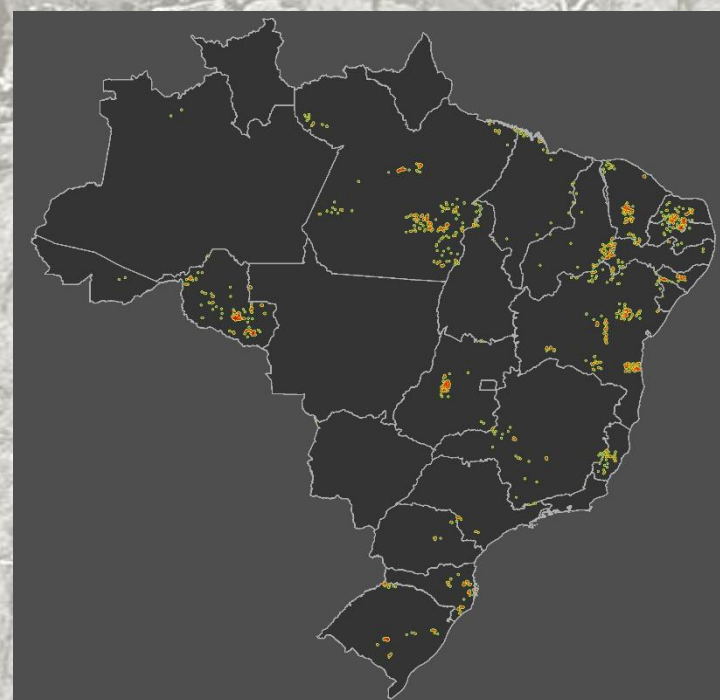
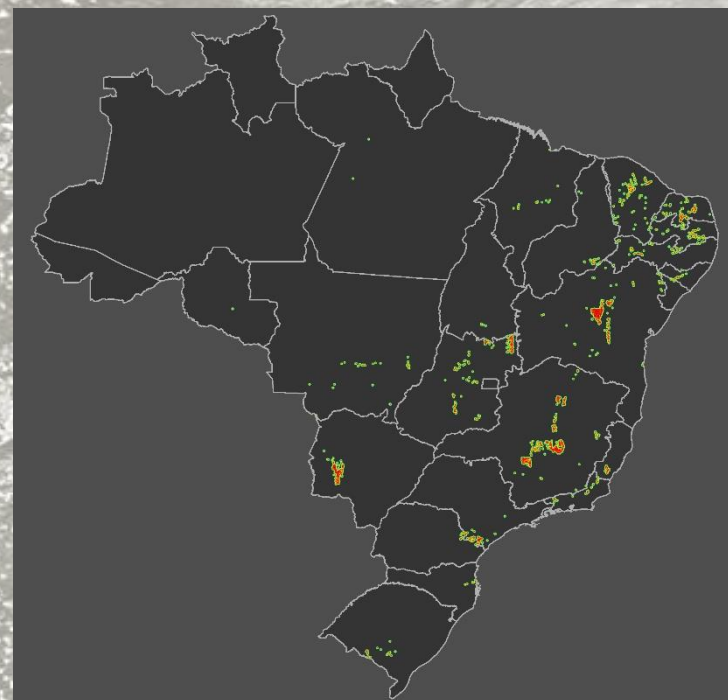


# Fertilizante – Ca, Mg

Aflo. Calcisil.

CaO  $\geq$  30%

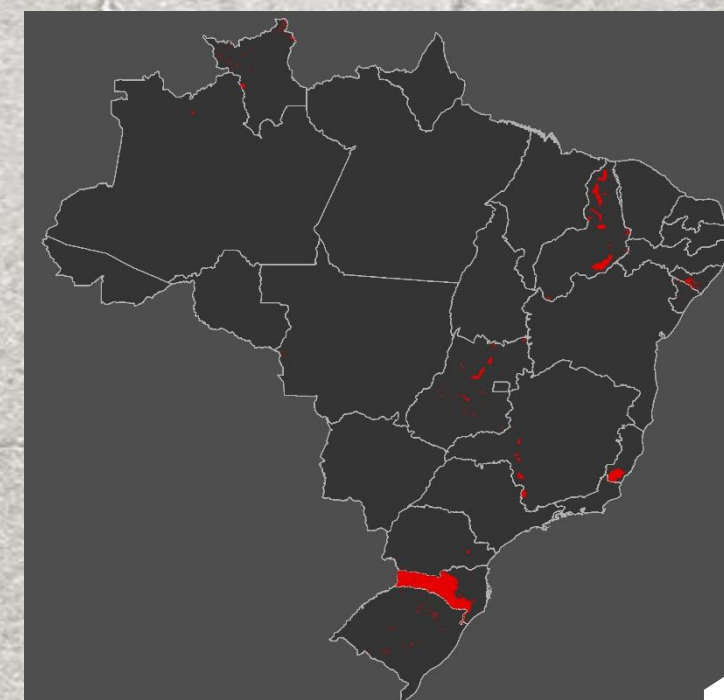
CaO + MgO  $\geq$  20%



DNPM Mármore

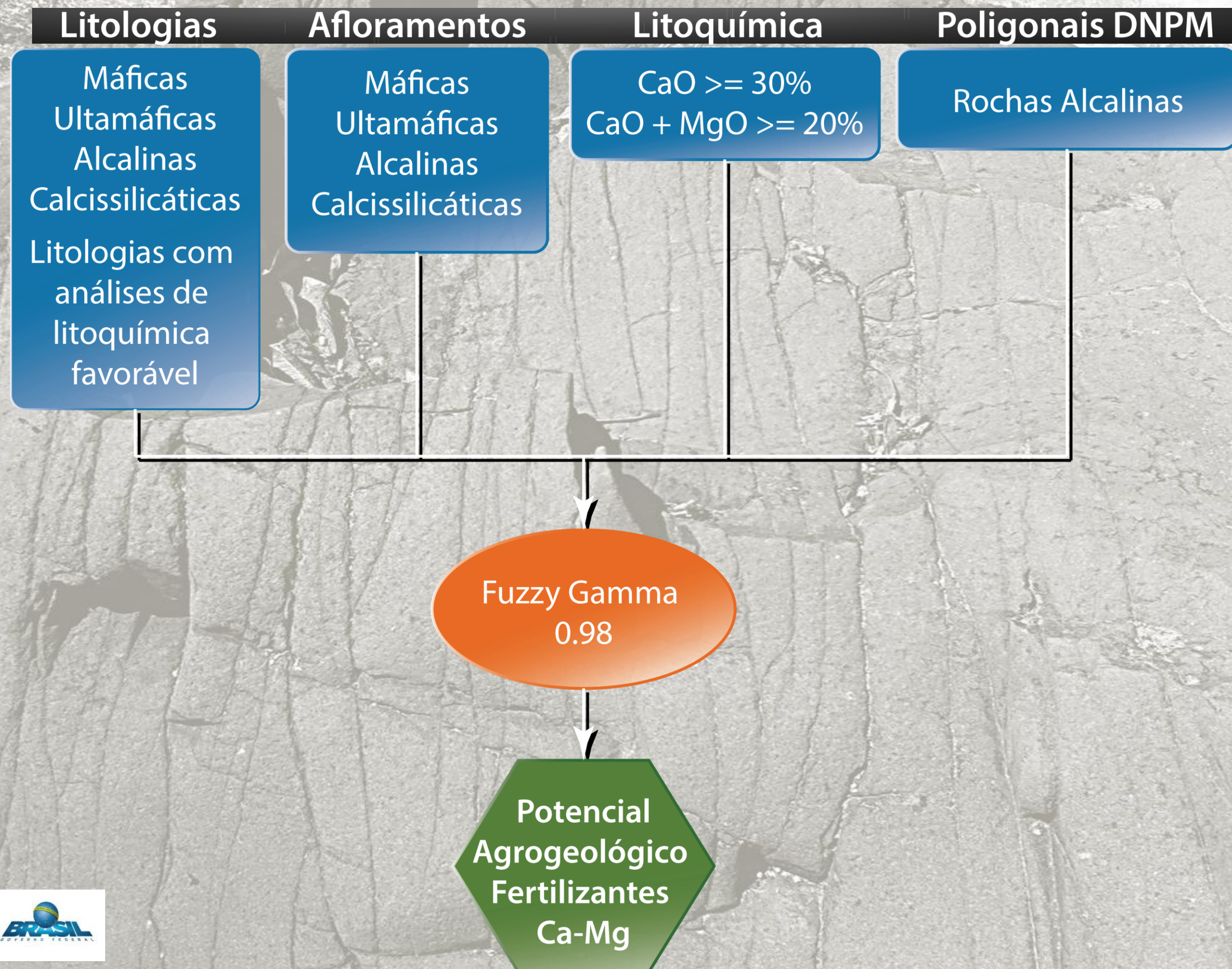
DNPM Alcalina

ARIM Fertilizantes  
Ca, Mg





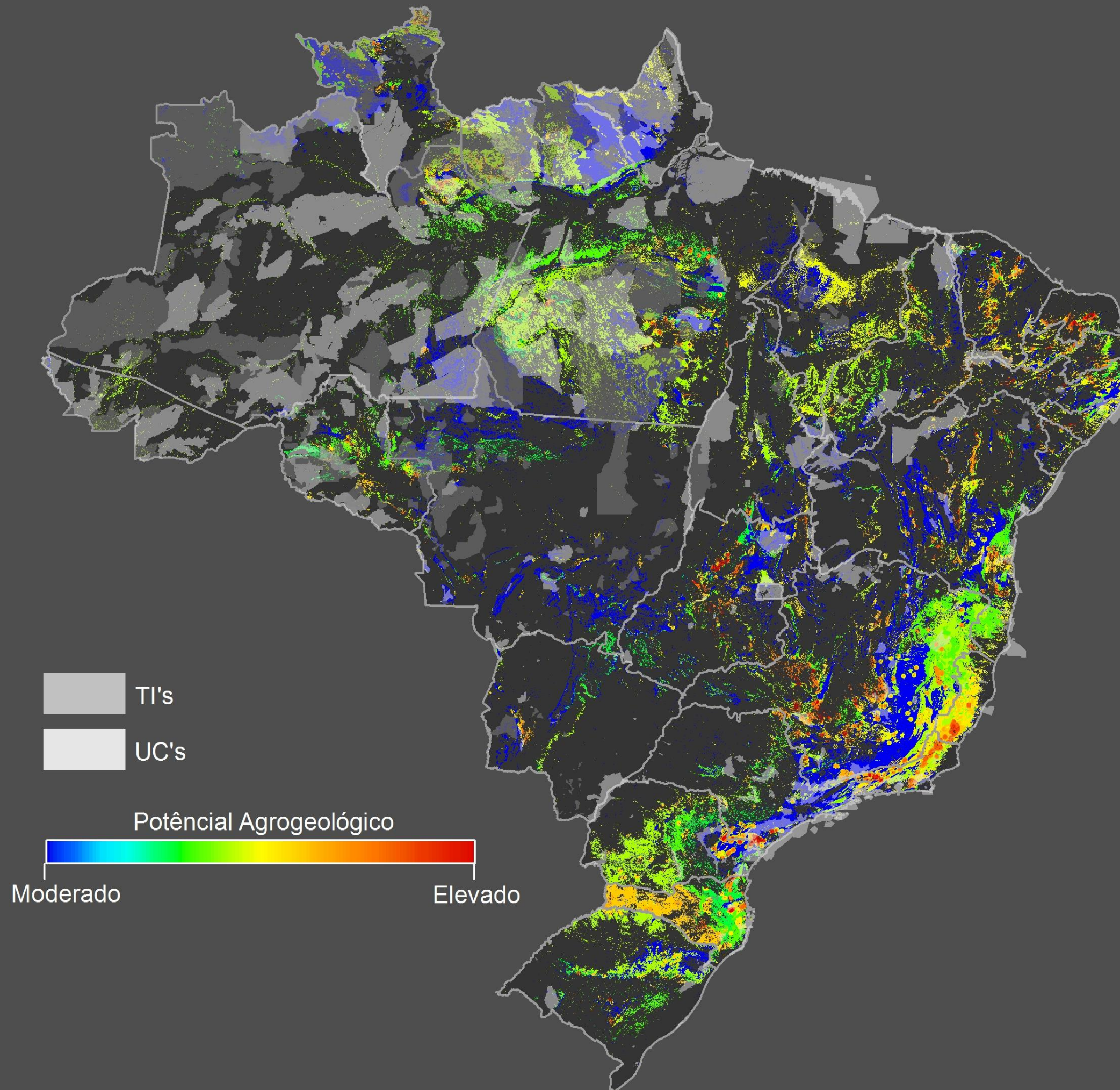
# Fertilizante – Ca, Mg





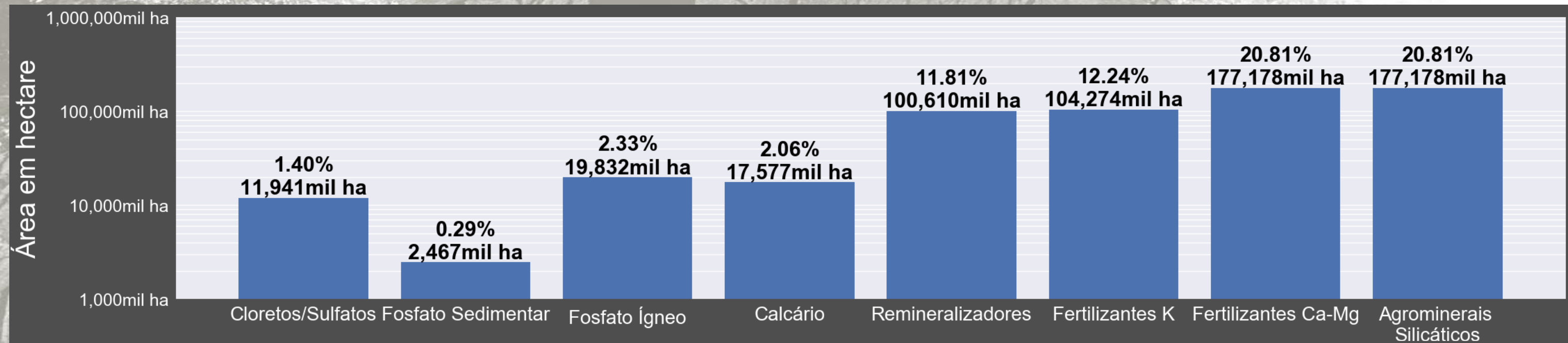
# Fertilizante Ca, Mg

## Integração

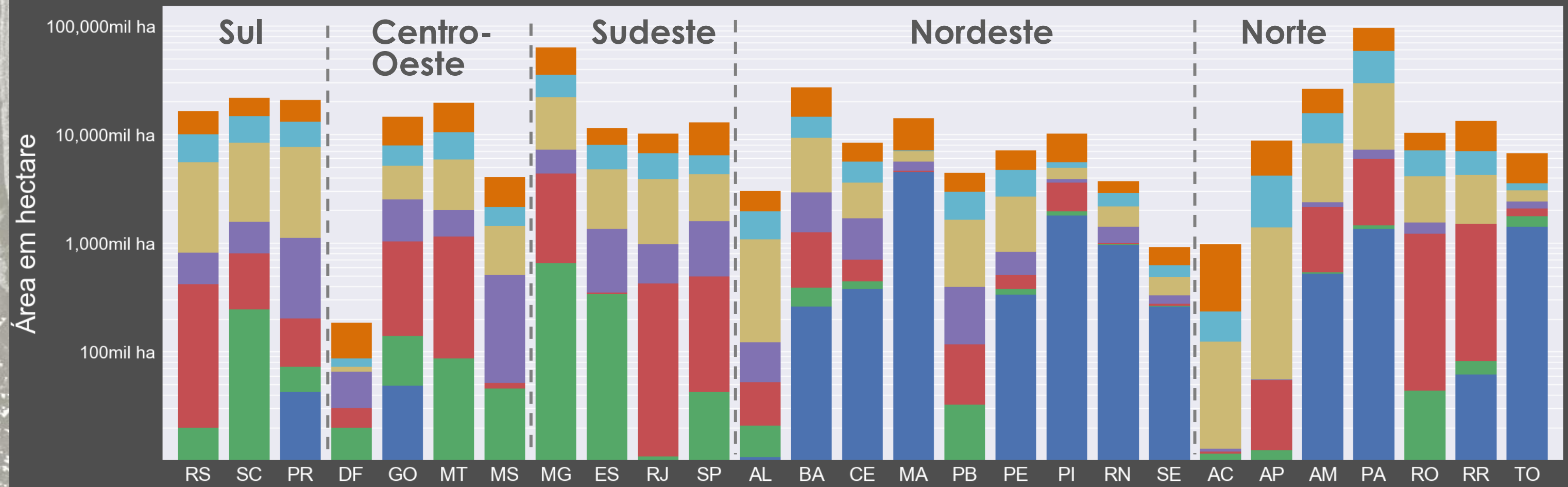




# Potencial de ocorrência para Agrominerais no Brasil



Área Total com Potencial para Agrominerais no Brasil por Estado

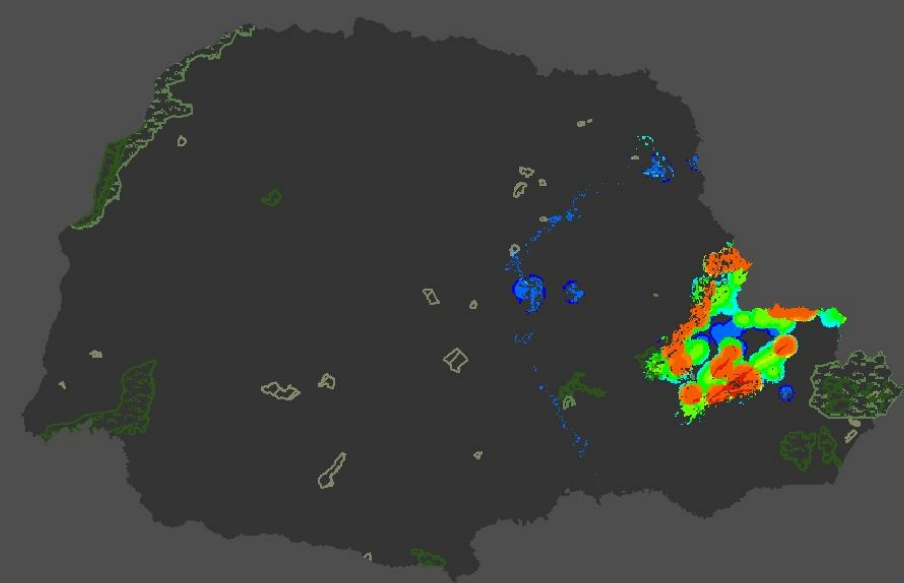




# Potencial para Agrominerais- PR



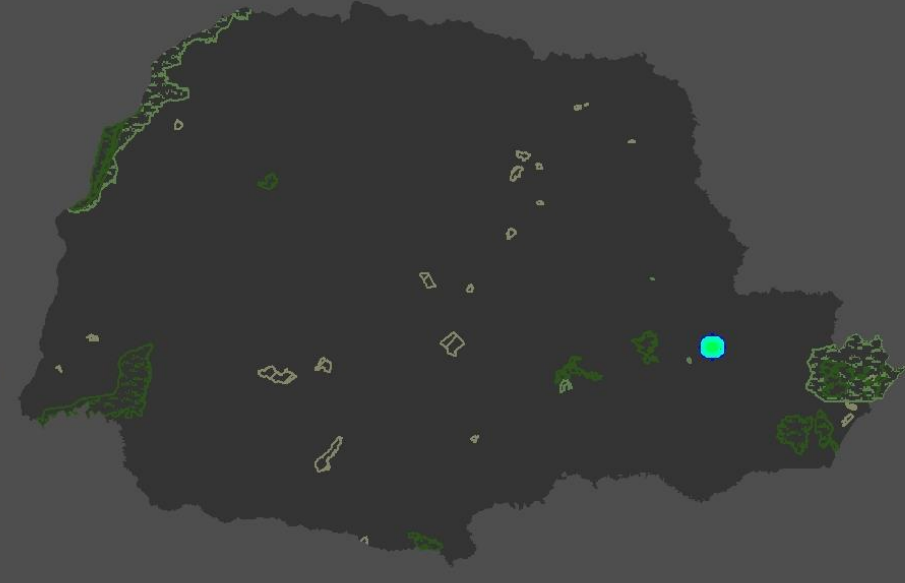
Carbonatos



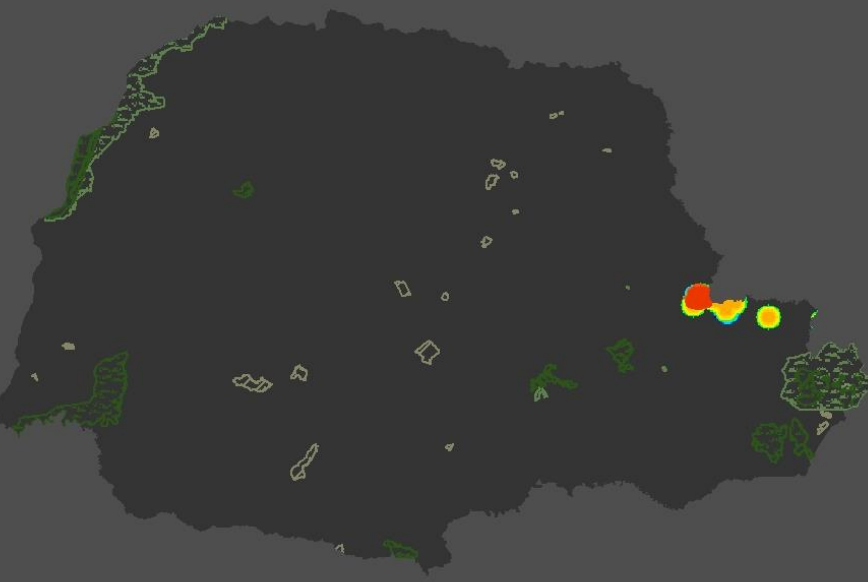
Cloretos/Sulfatos



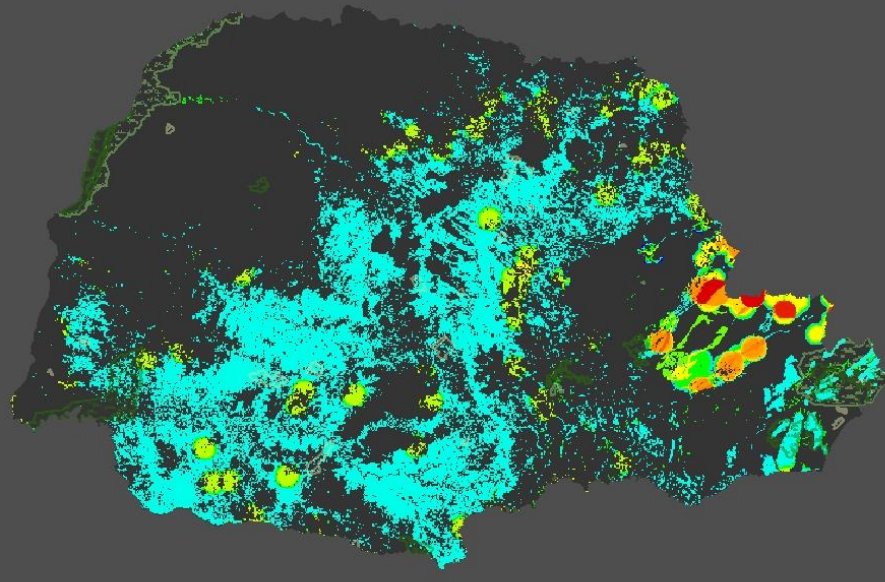
Fosfato Sedimentar



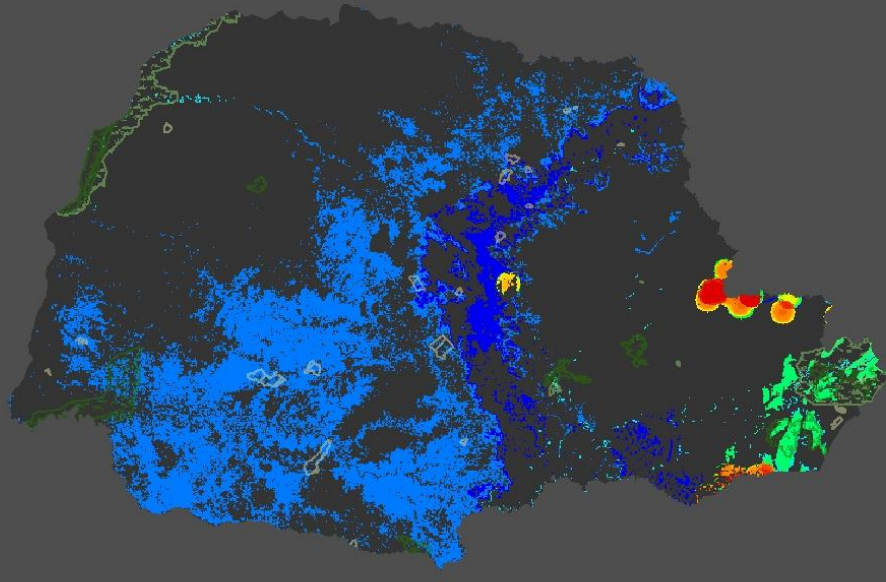
Fosfato Ígneo



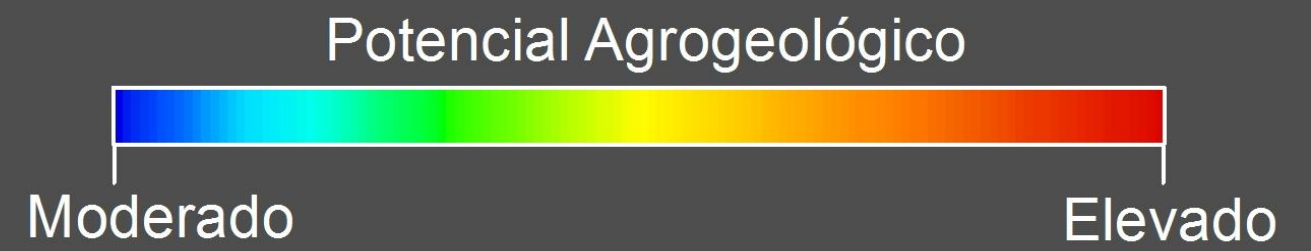
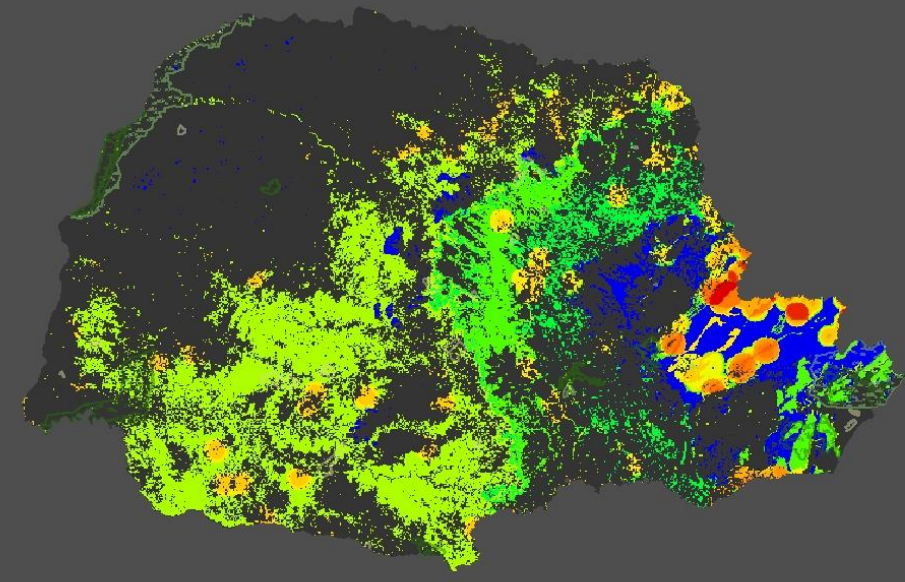
Remineralizadores



Fertilizantes K

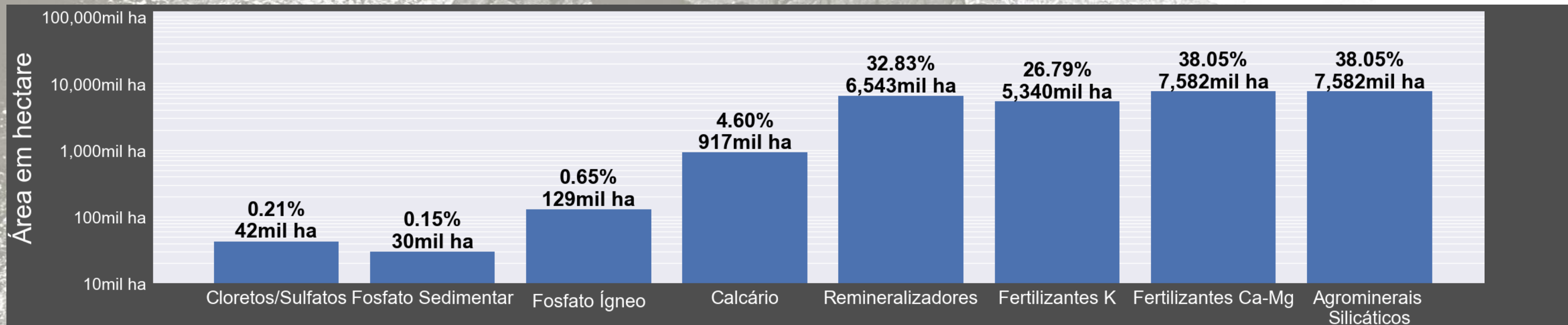


Fertilizantes Ca-Mg

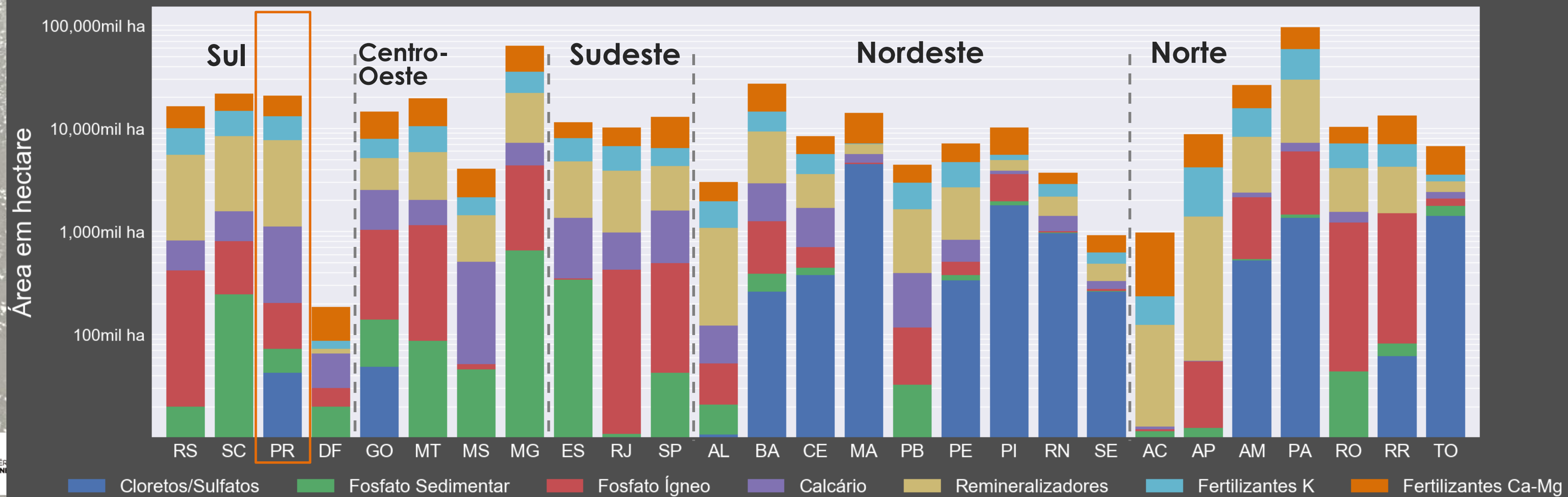




# Potencial de ocorrência para Agrominerais - PR



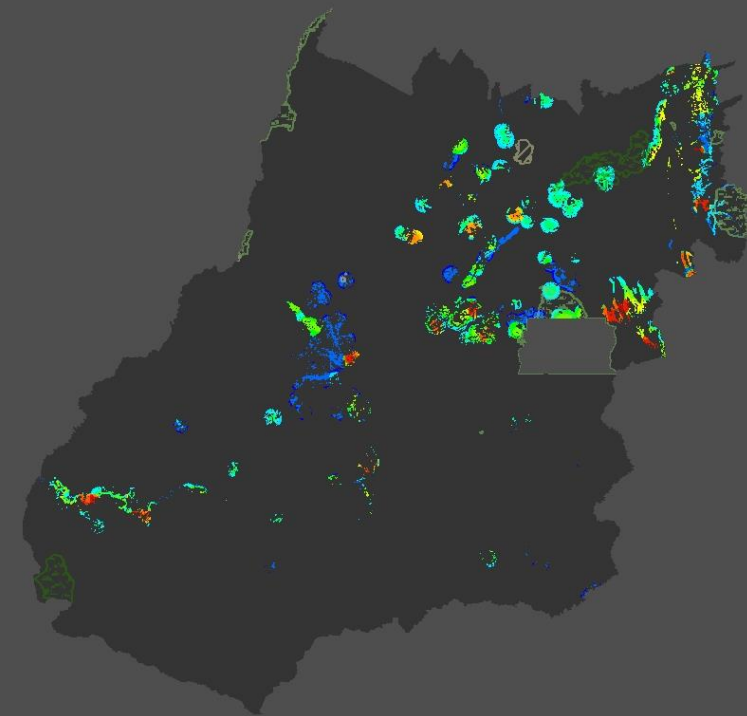
Área Total com Potencial para Agrominerais no Brasil por Estado



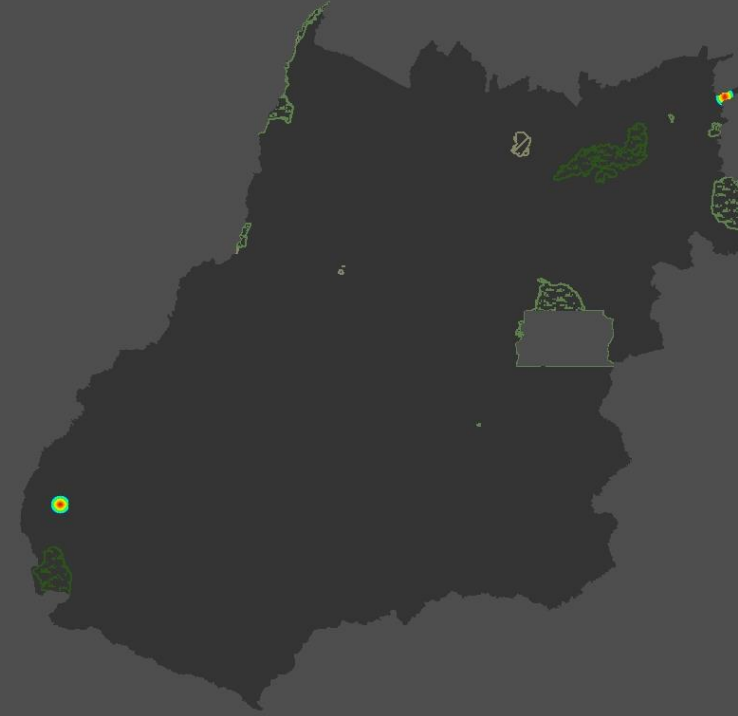


# Potencial para Agrominerais - GO

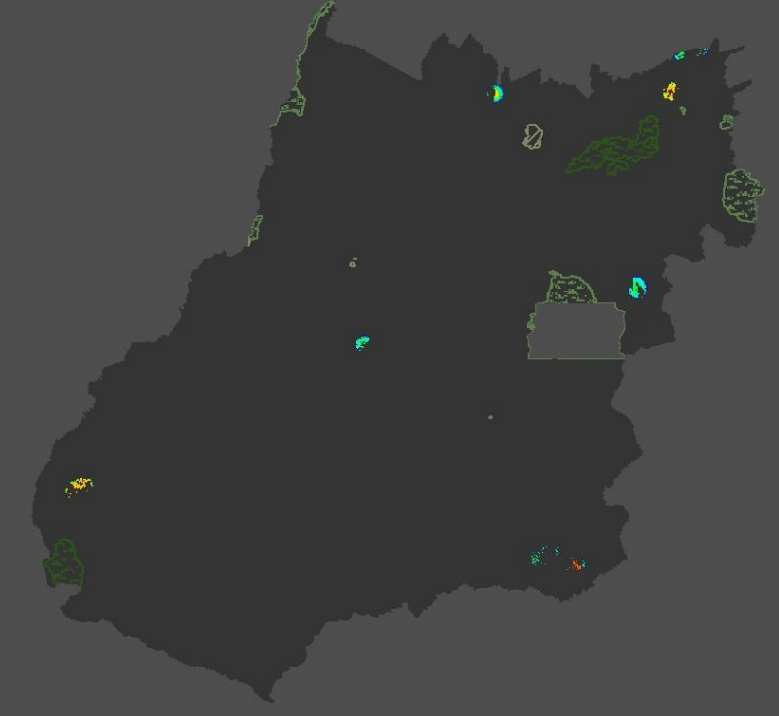
Carbonatos



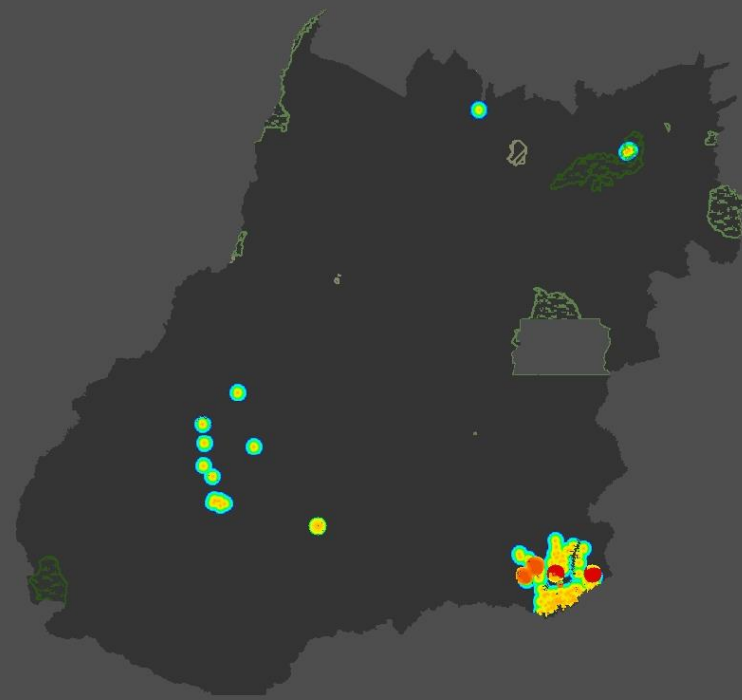
Cloretos/Sulfatos



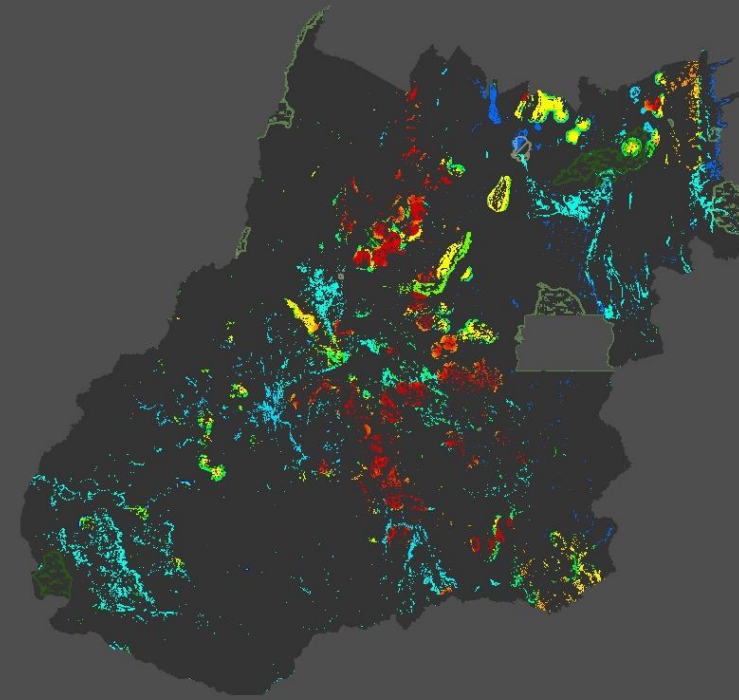
Fosfato Sedimentar



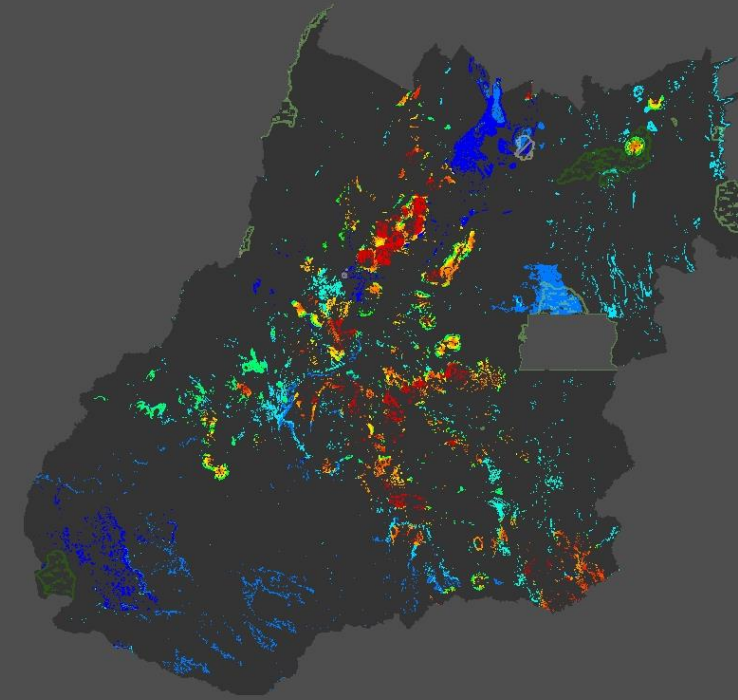
Fosfato Ígneo



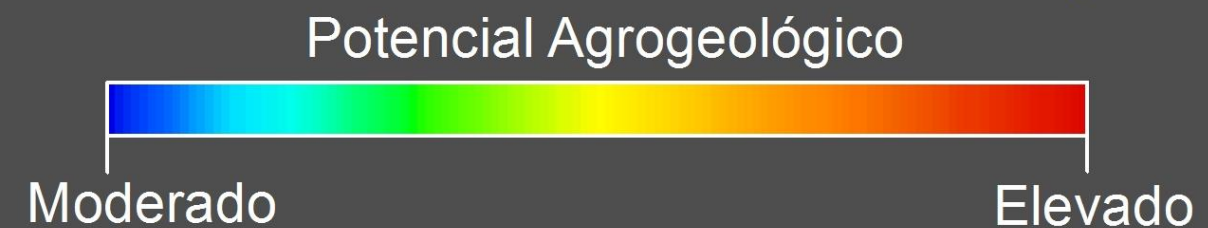
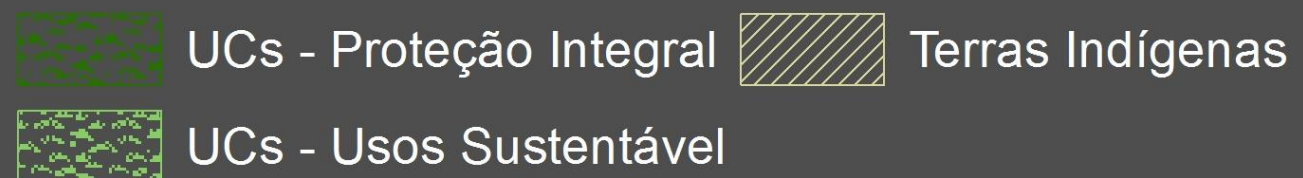
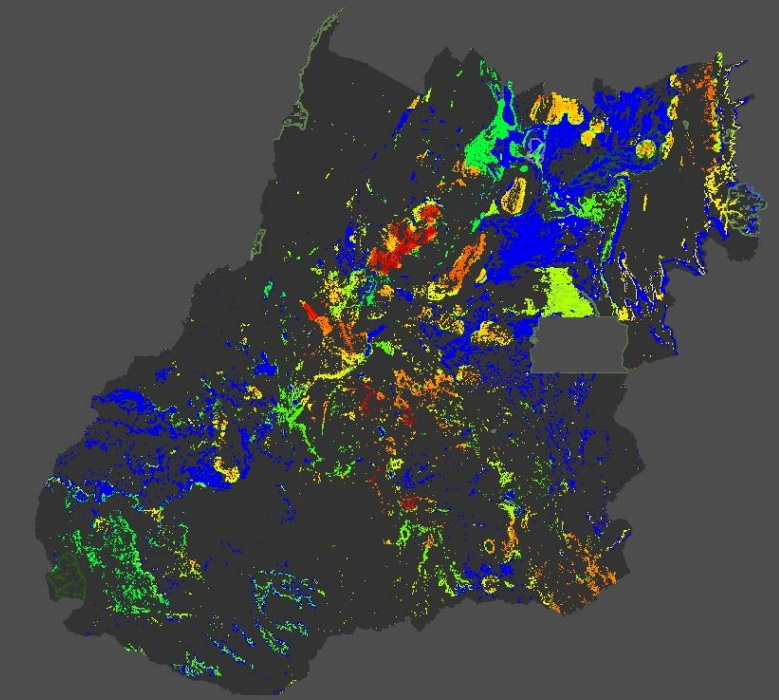
Remineralizadores



Fertilizantes K



Fertilizantes Ca-Mg

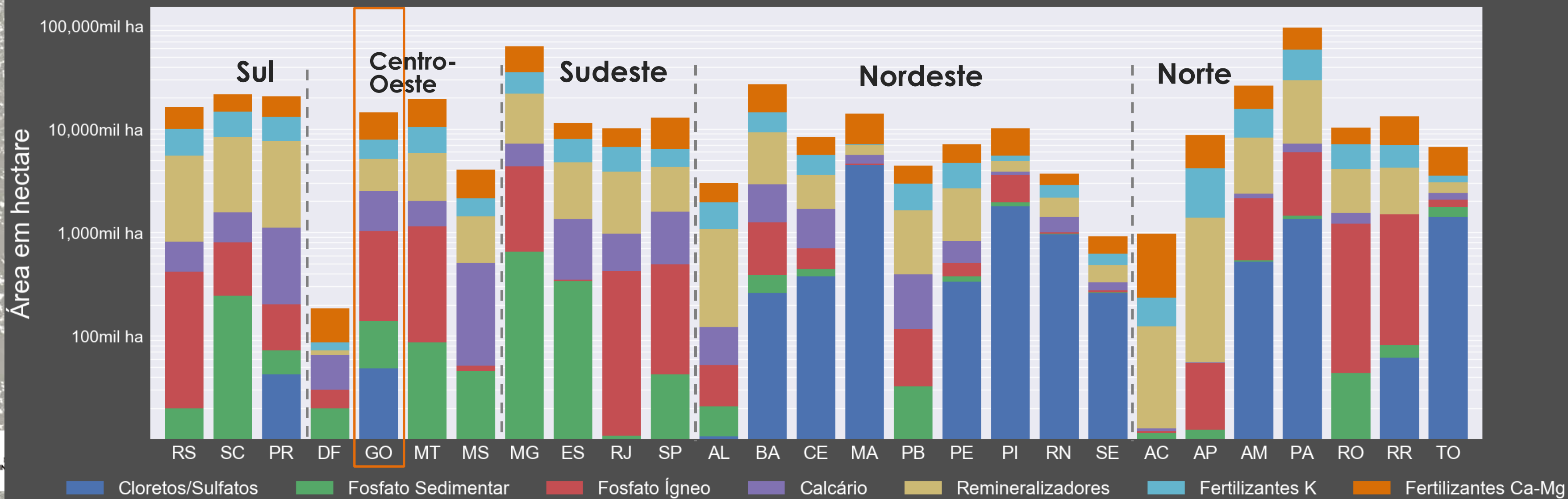




# Potencial de ocorrência para Agrominerais - GO



Área Total com Potencial para Agrominerais no Brasil por Estado



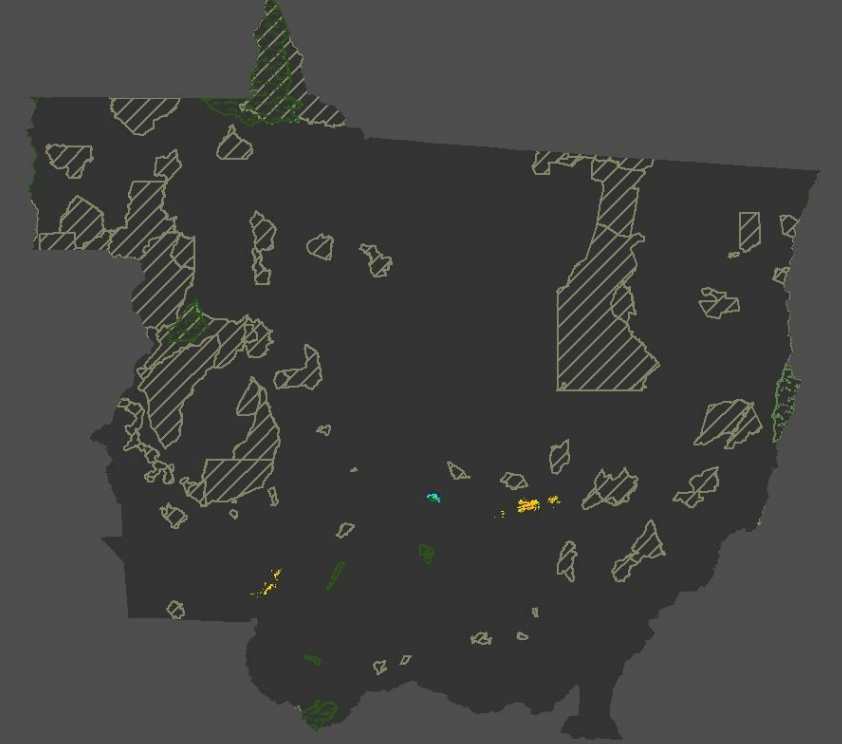
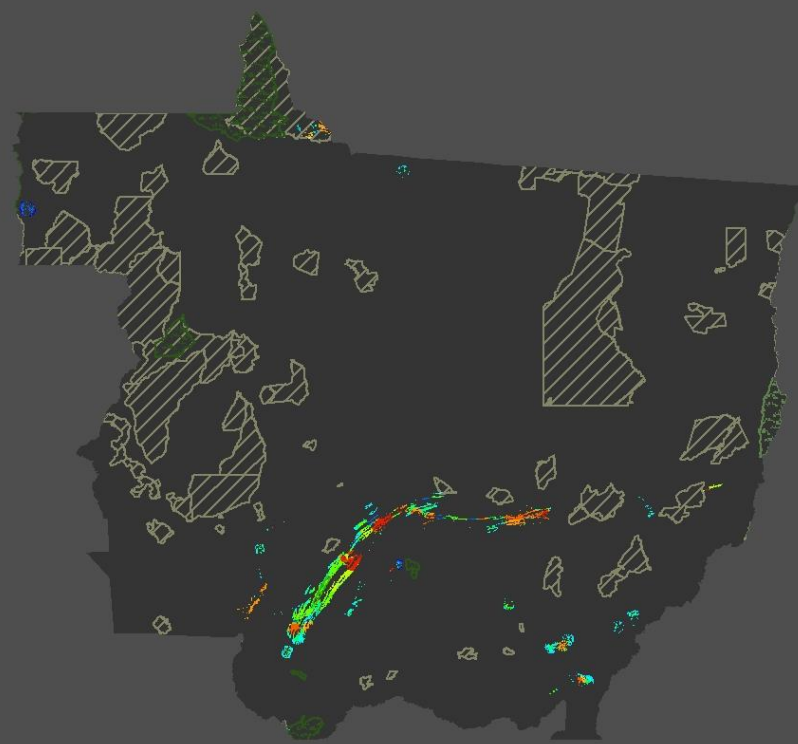


# Potencial para Agrominerais- MT

Carbonatos

Cloretos/Sulfatos

Fosfato Sedimentar

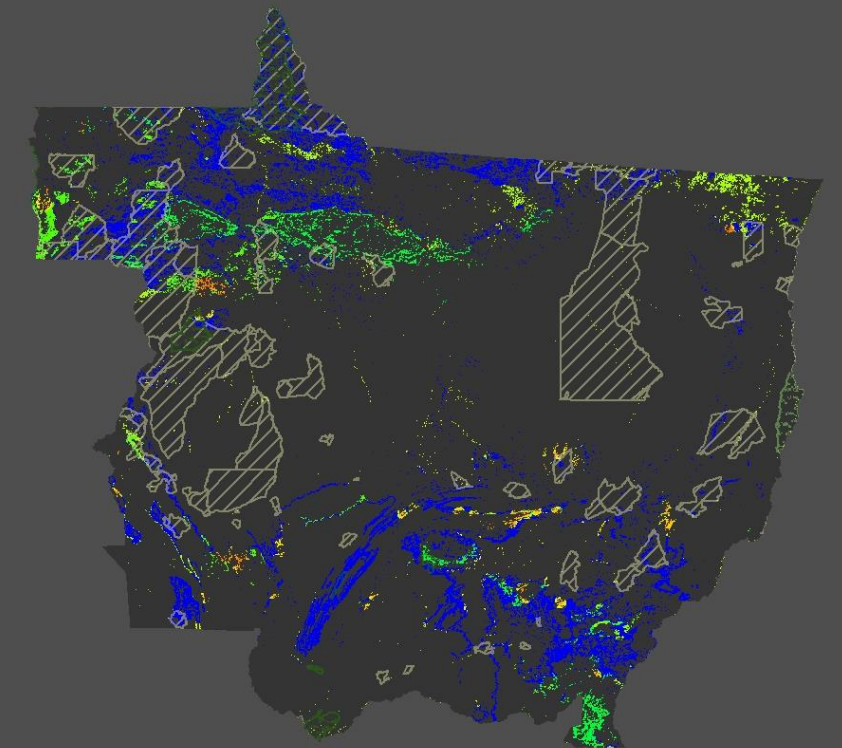
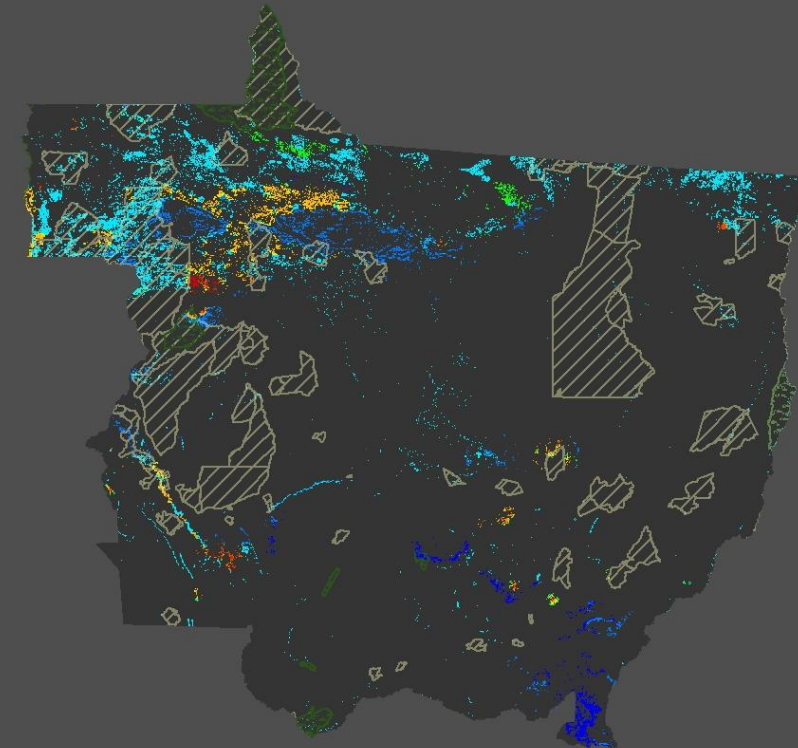
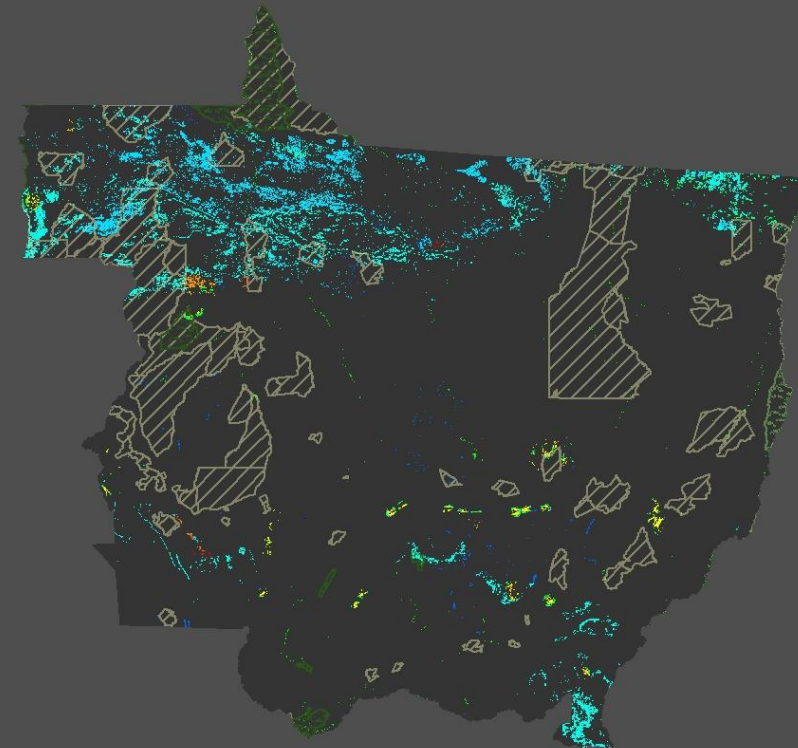
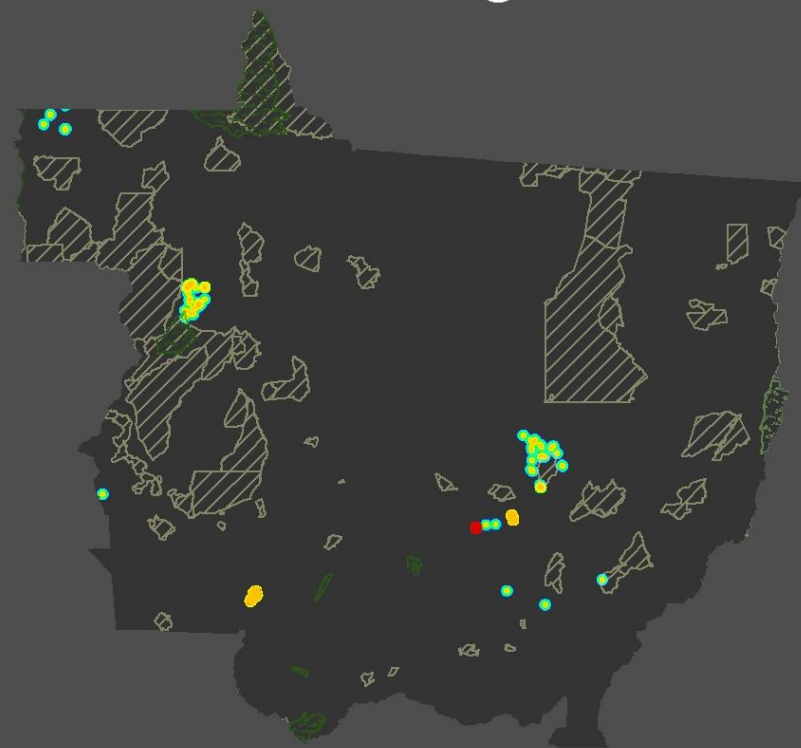


Fosfato Ígneo

Remineralizadores

Fertilizantes K

Fertilizantes Ca-Mg

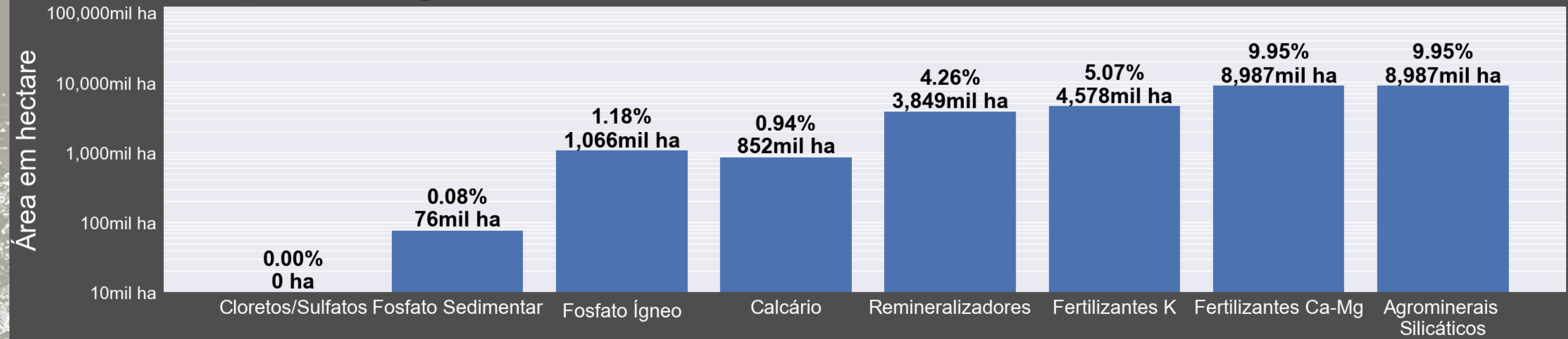


Potencial Agrogeológico

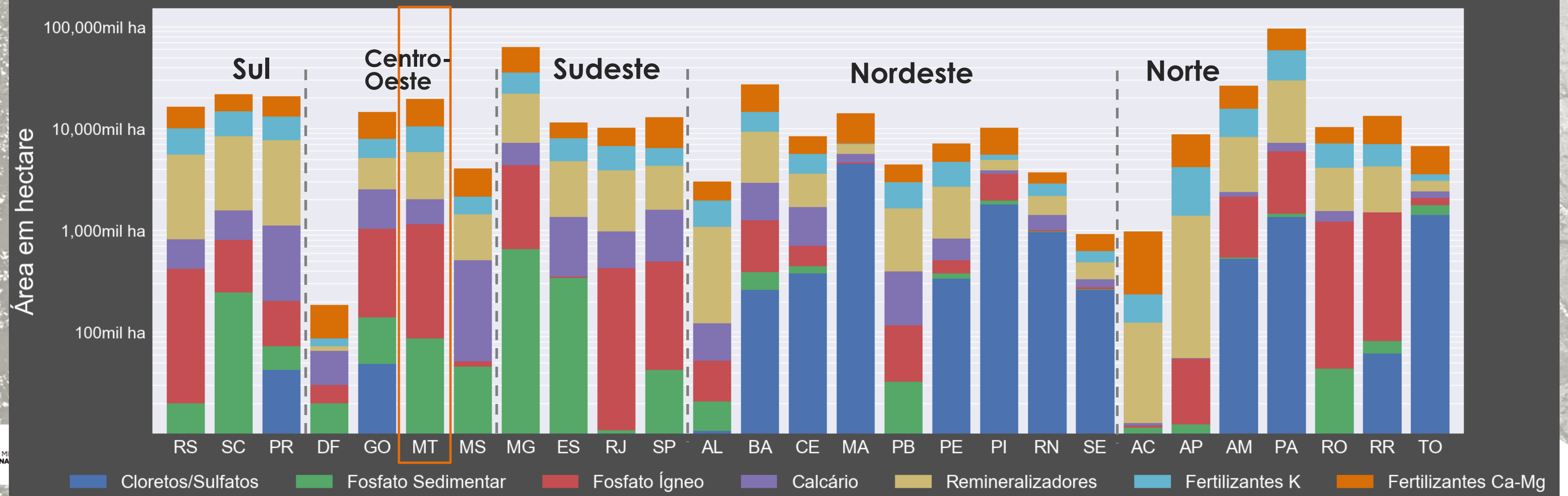




# Potencial para Agrominerais - MT



Área Total com Potencial para Agrominerais no Brasil por Estado



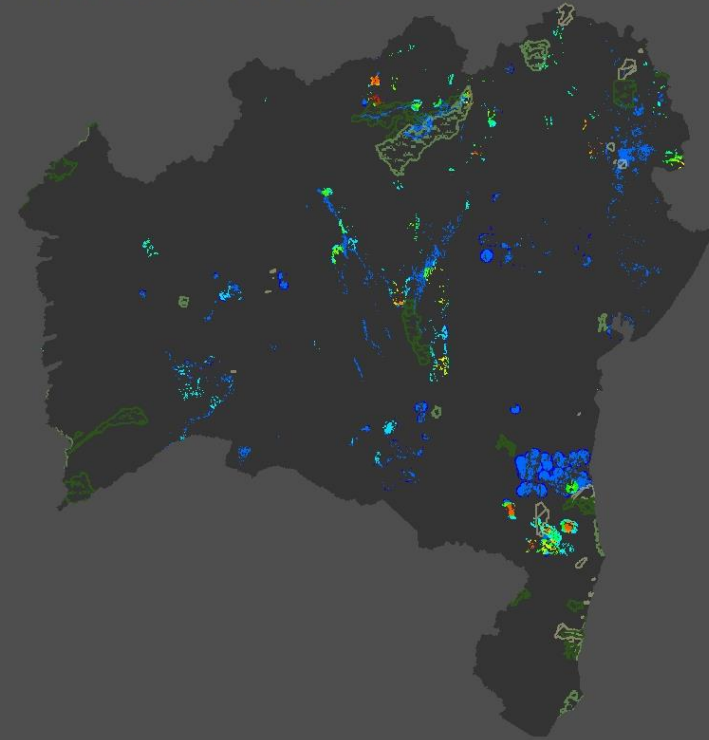


# Potencial para Agrominerais - BA

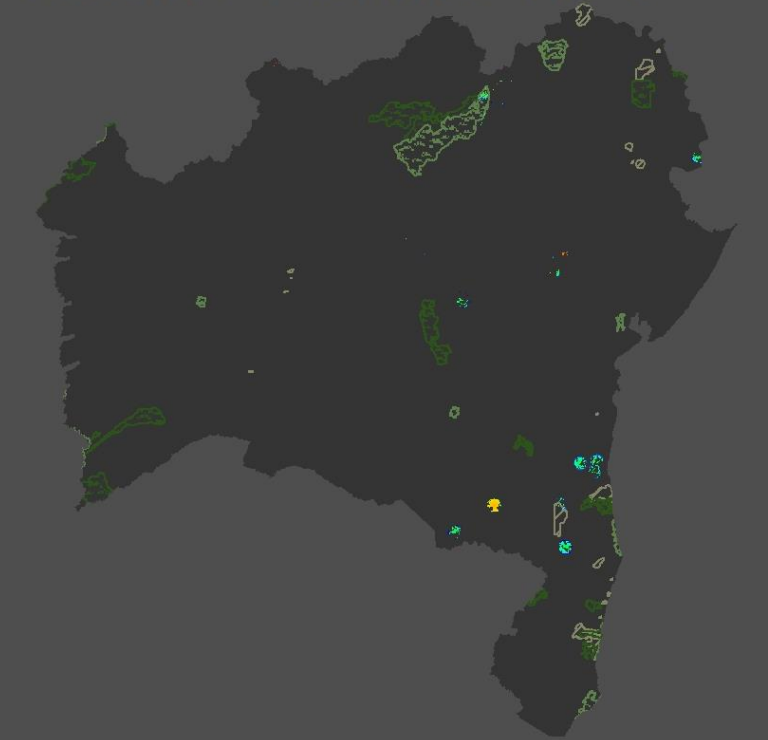
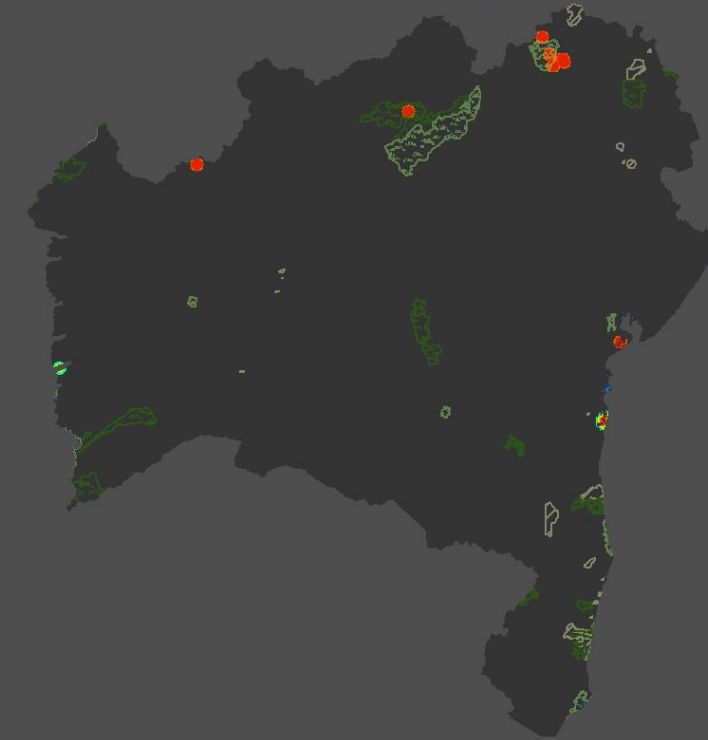
Carbonatos



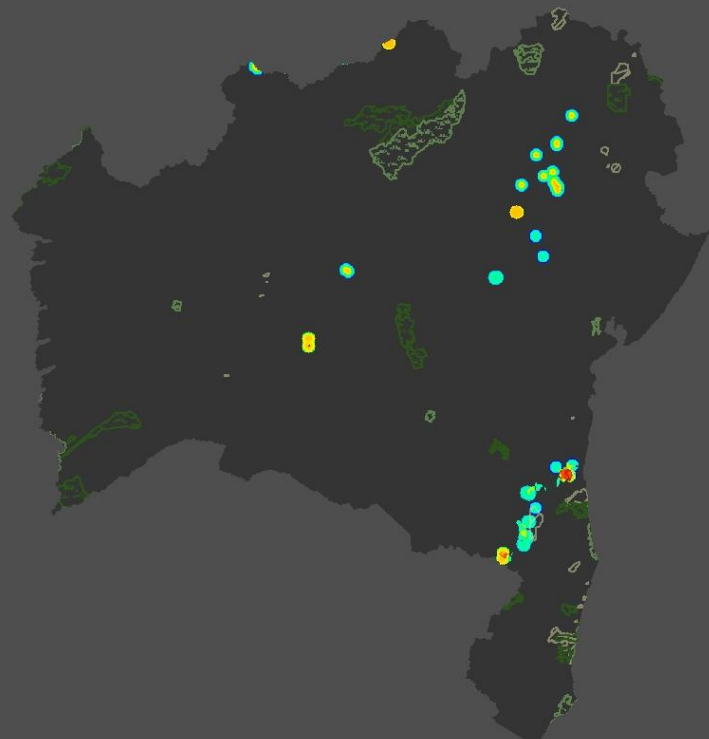
Cloretos/Sulfatos



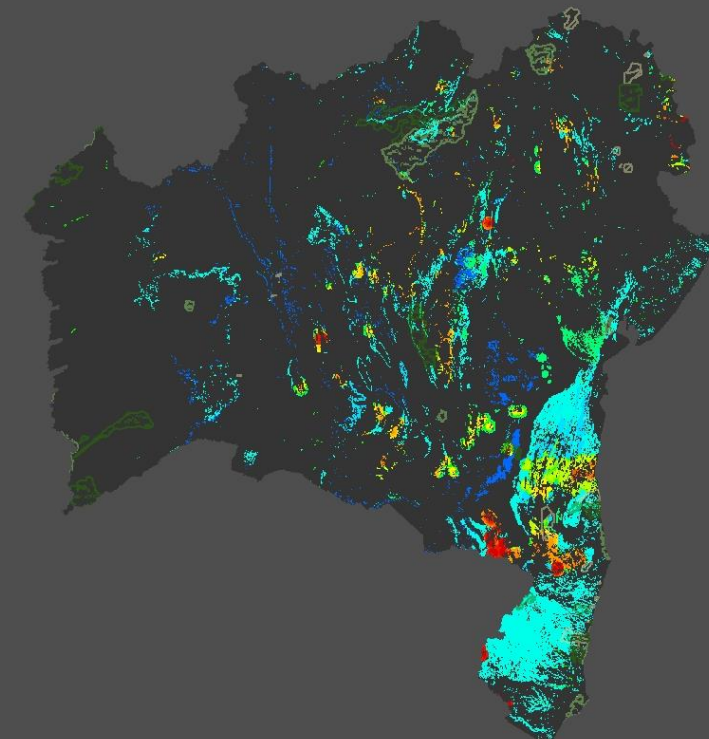
Fosfato Sedimentar



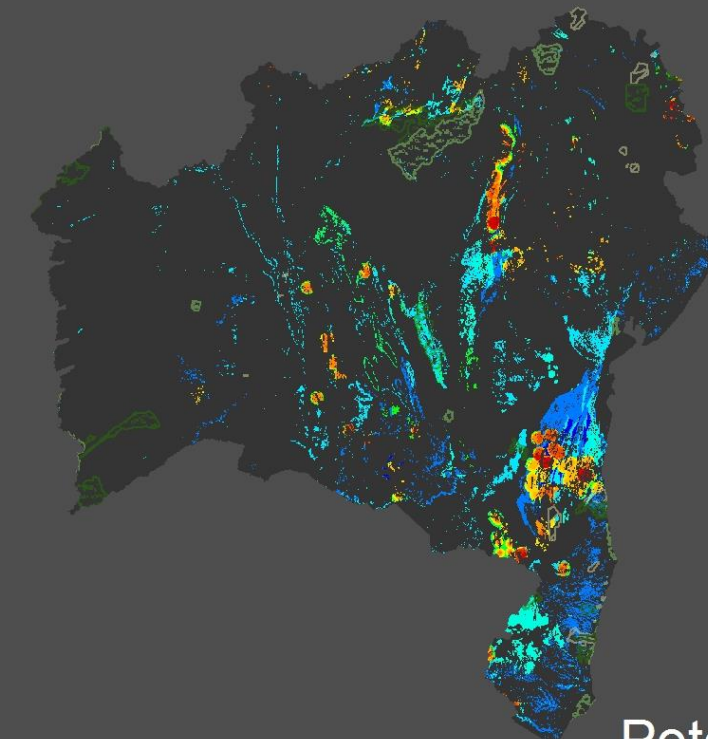
Fosfato Ígneo



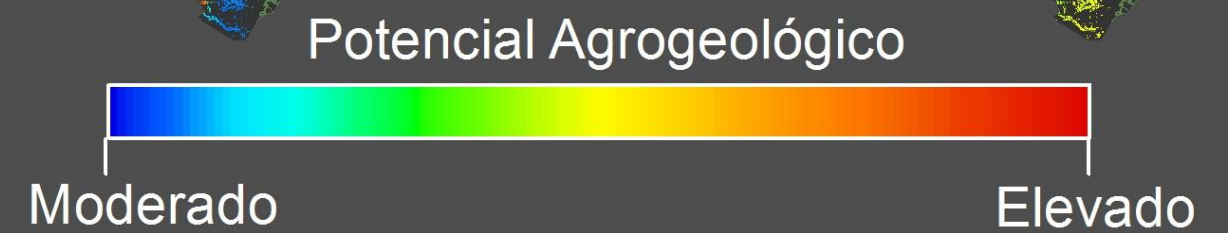
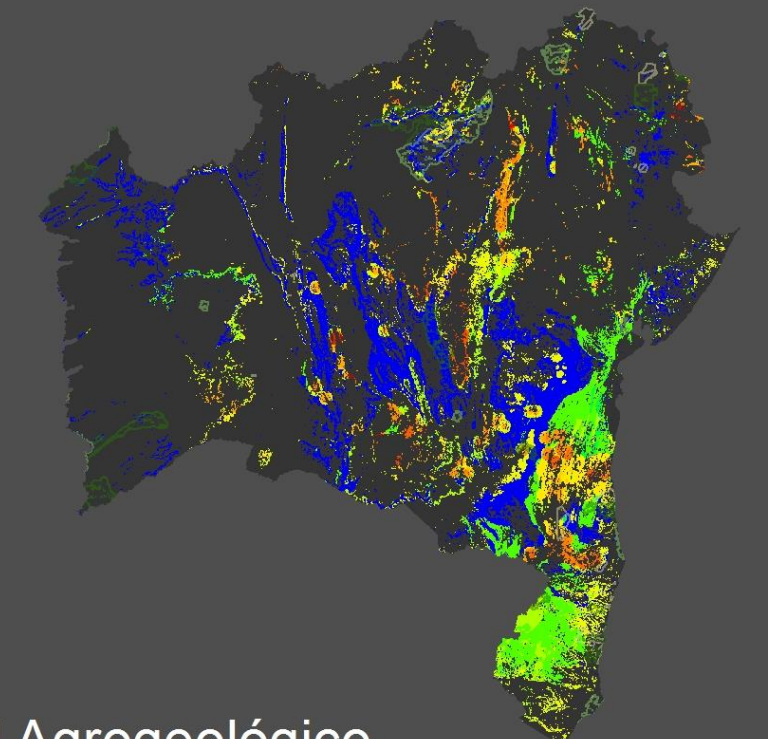
Remineralizadores



Fertilizantes K

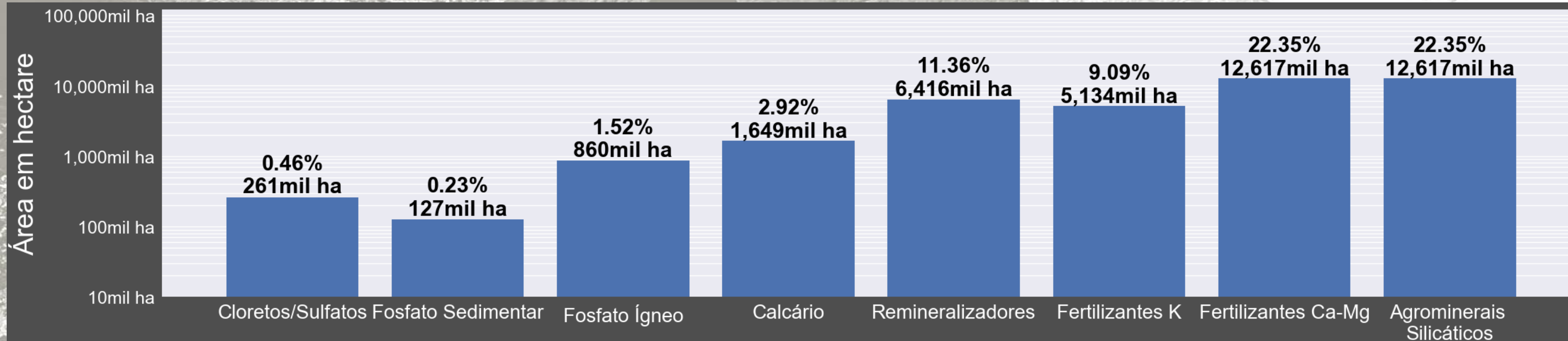


Fertilizantes Ca-Mg

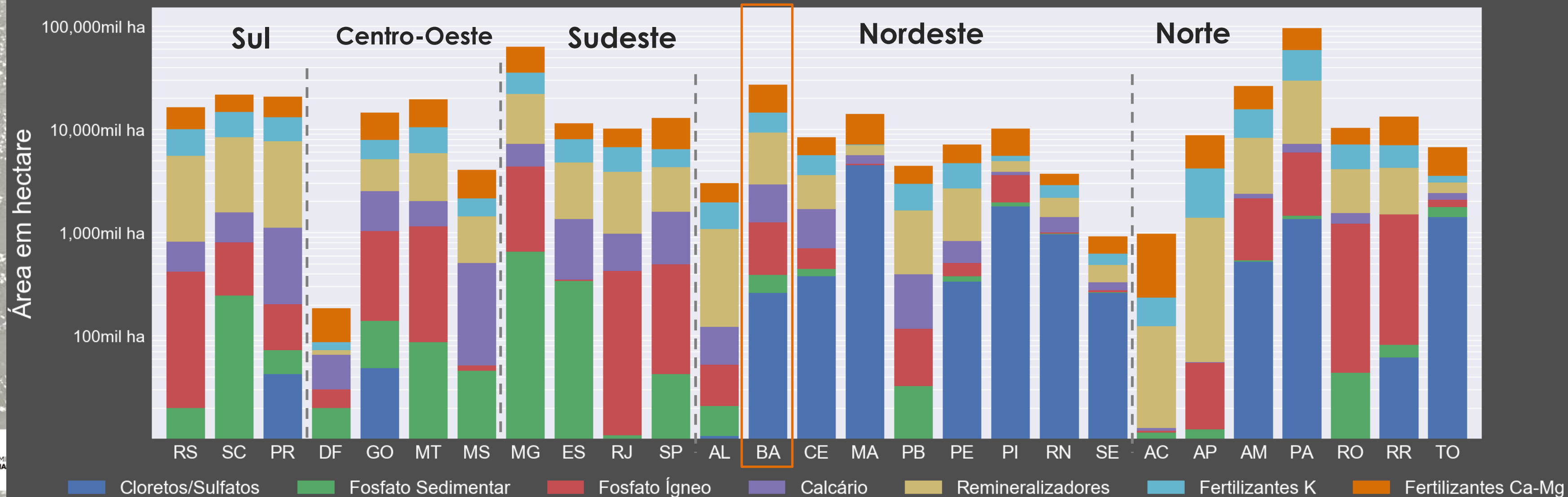




# Potencial para Agrominerais - BA



Área Total com Potencial para Agrominerais no Brasil por Estado

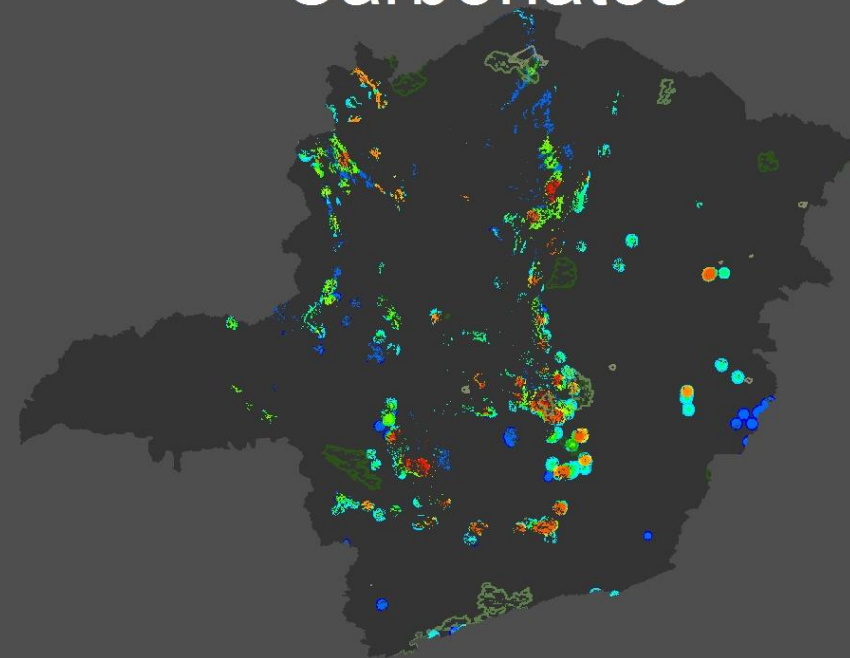




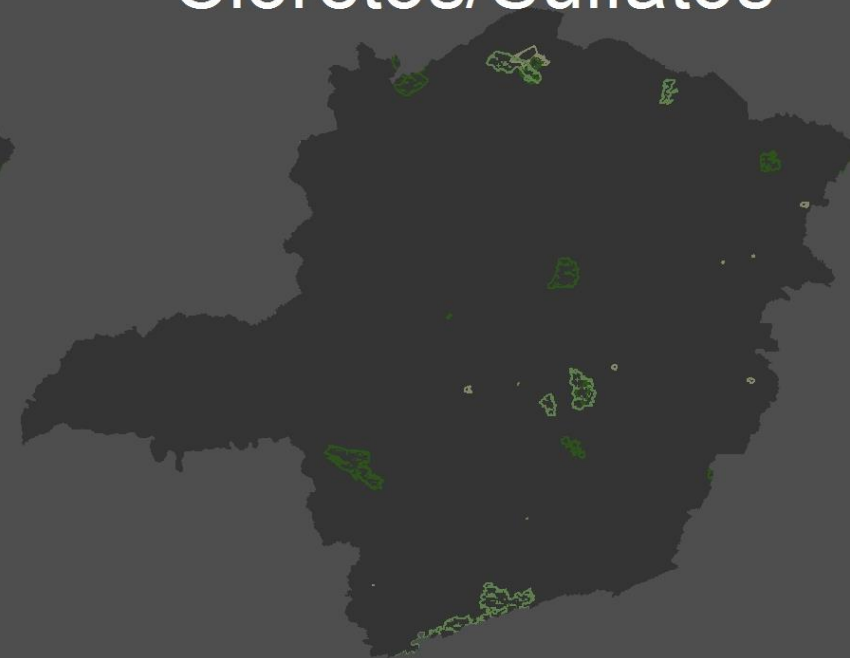
# Potencial Agrogeológico para Fertilizantes - MG



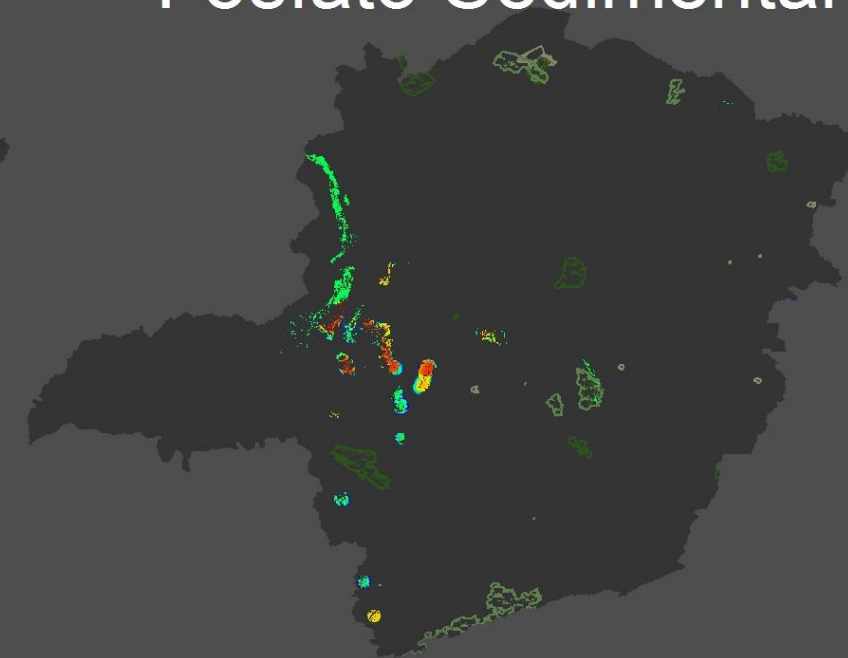
Carbonatos



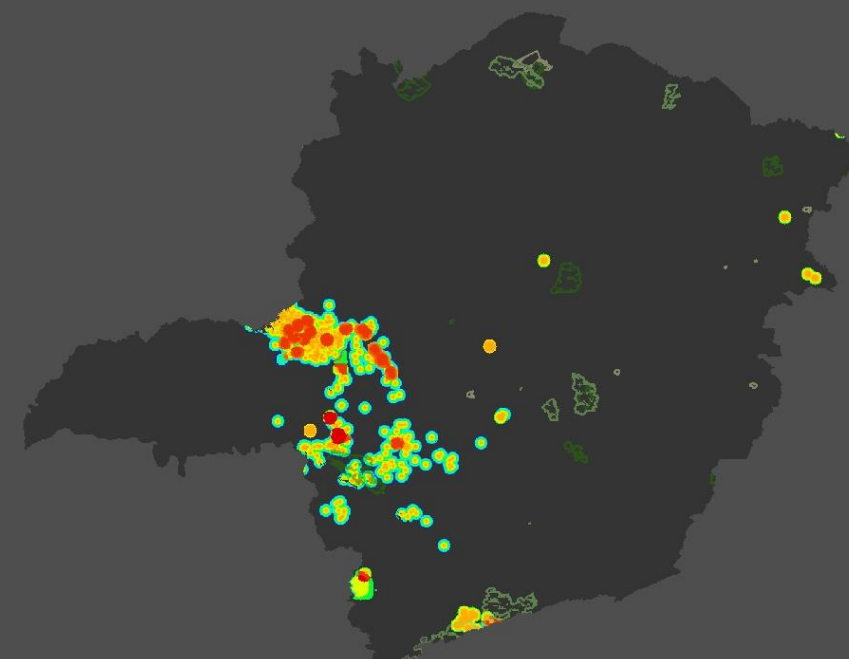
Cloretos/Sulfatos



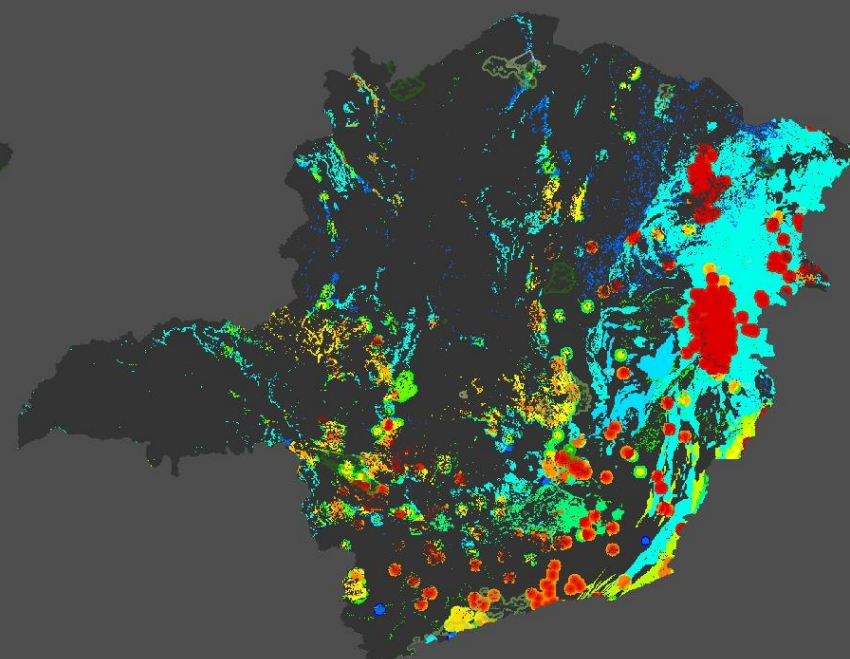
Fosfato Sedimentar



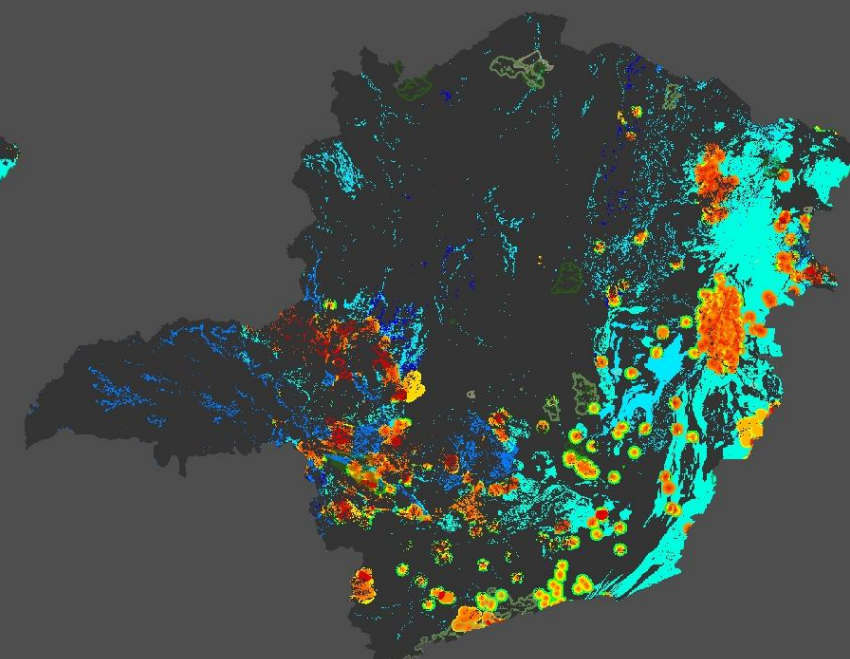
Fosfato Ígneo



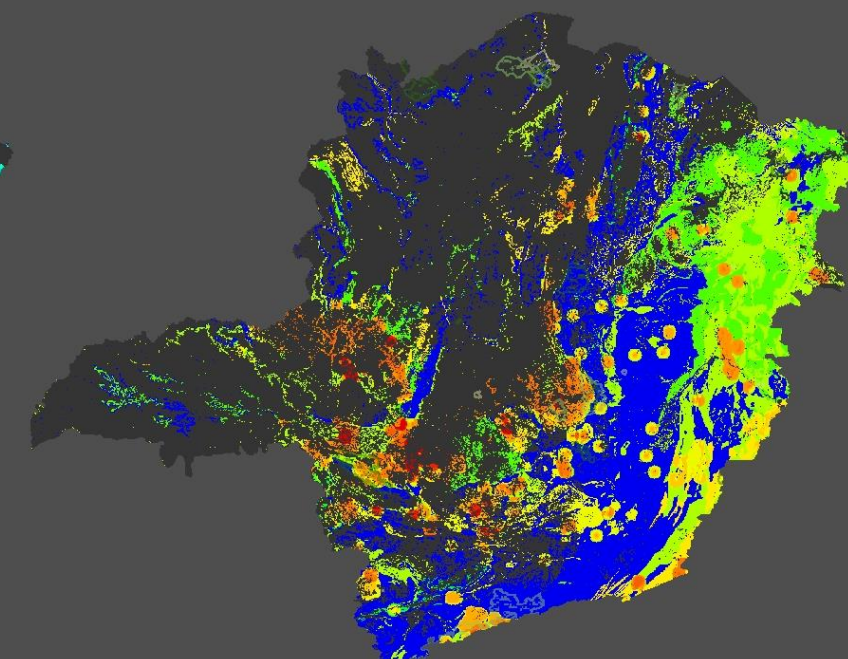
Remineralizadores



Fertilizantes Macronut. Essenciais



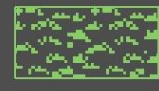
Fertilizantes Macronut. Secundários



UCs - Proteção Integral



Terras Indígenas



UCs - Usos Sustentável

Potencial Agrogeológico

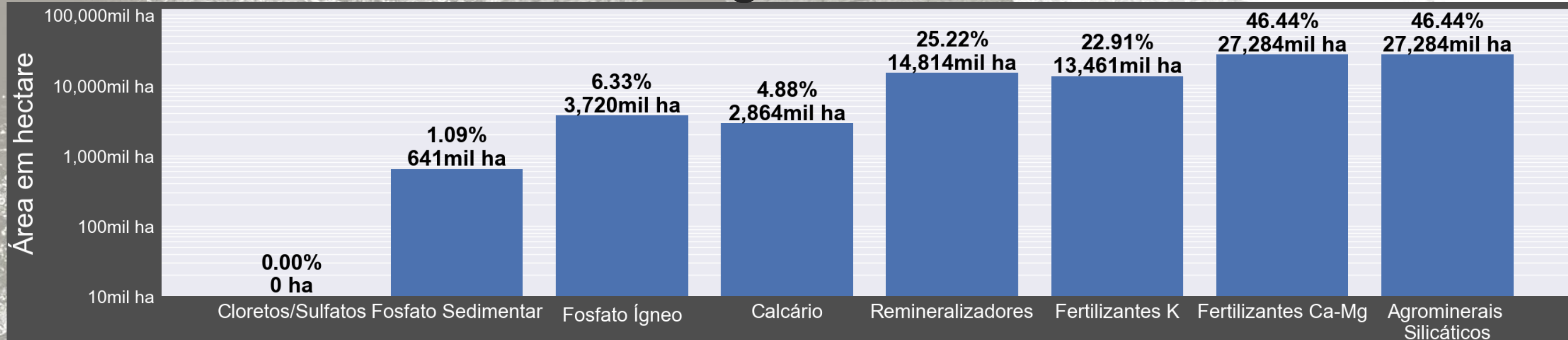


Moderado

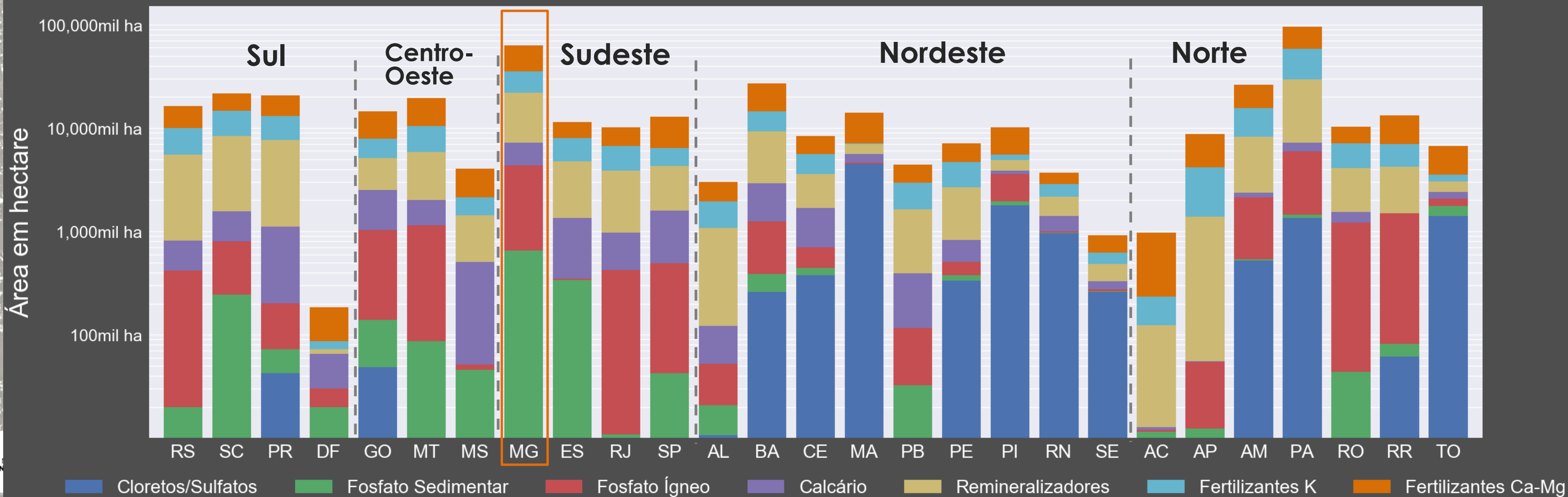
Elevado



# Potencial de Ocorrência de Agrominerais - MG



Área Total com Potencial para Agrominerais no Brasil por Estado



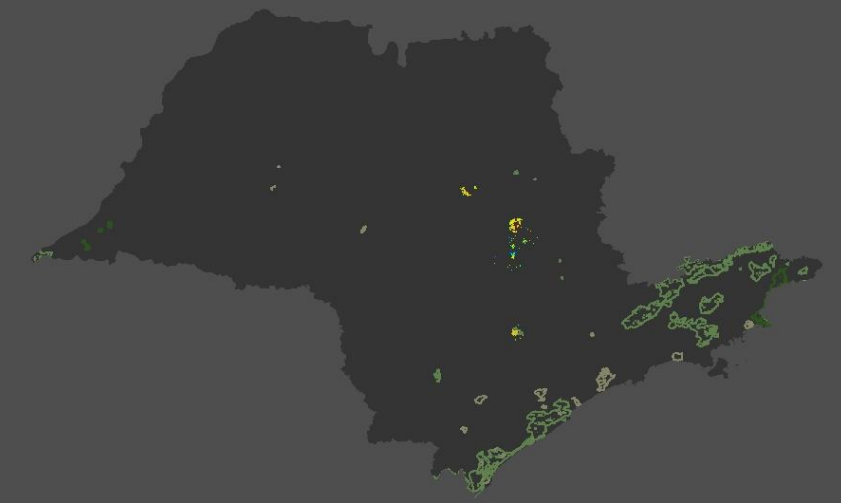
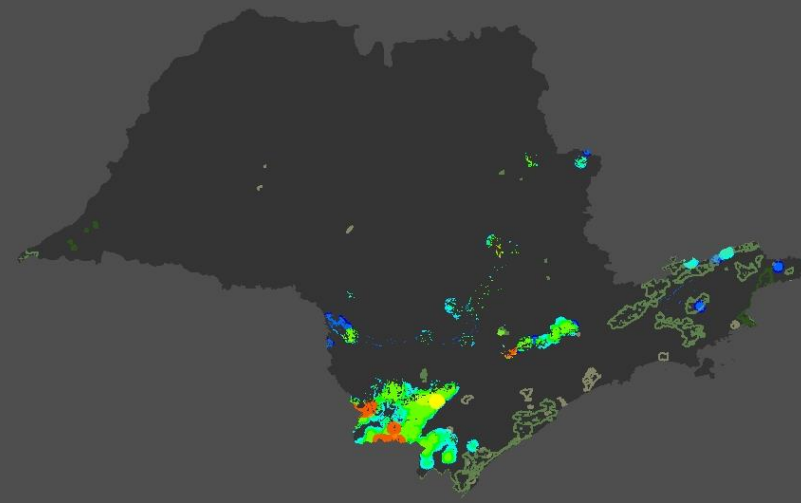


# Potencial Agrogeológico para Fertilizantes - SP

Carbonatos

Cloretos/Sulfatos

Fosfato Sedimentar

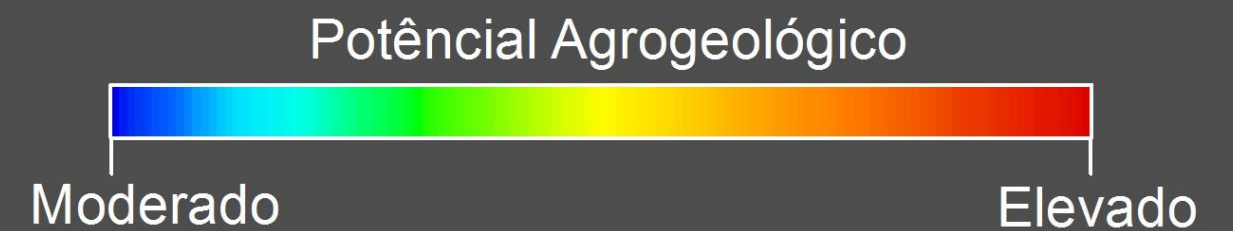
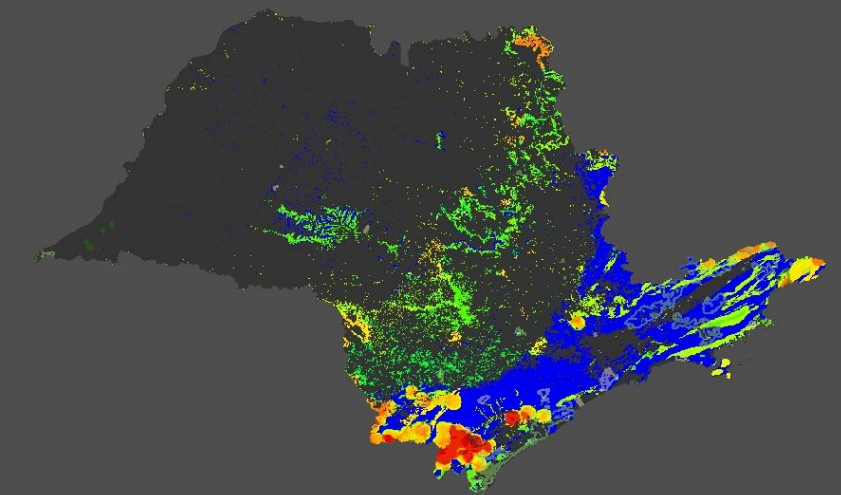
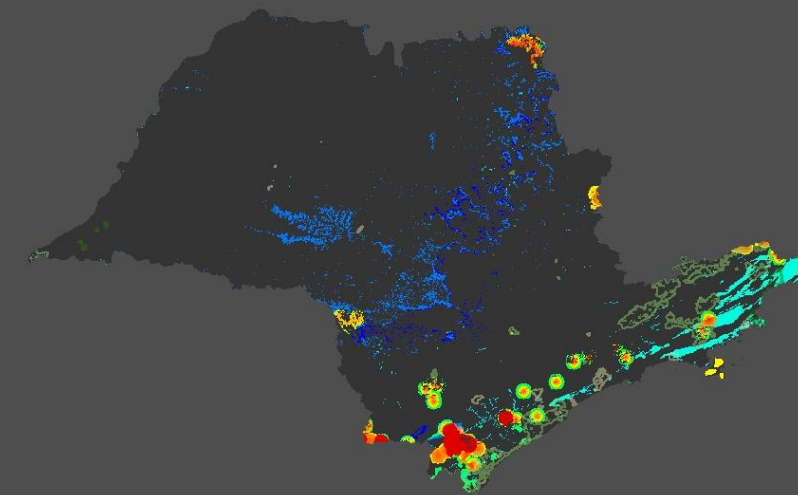
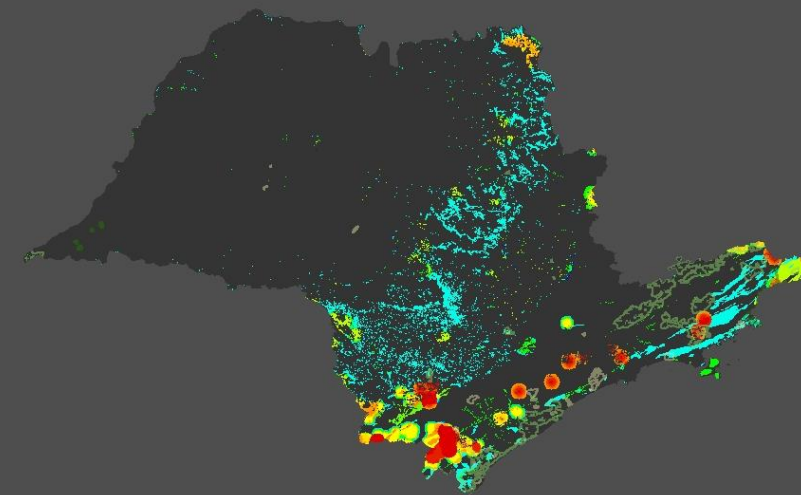
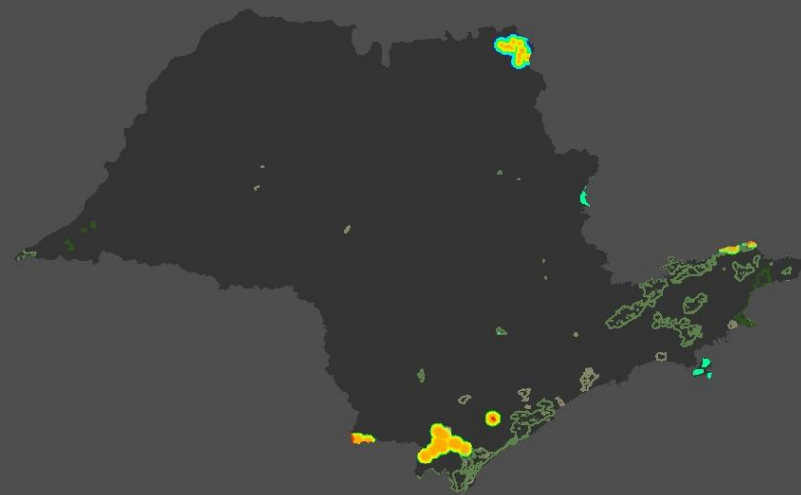


Fosfato Ígneo

Remineralizadores

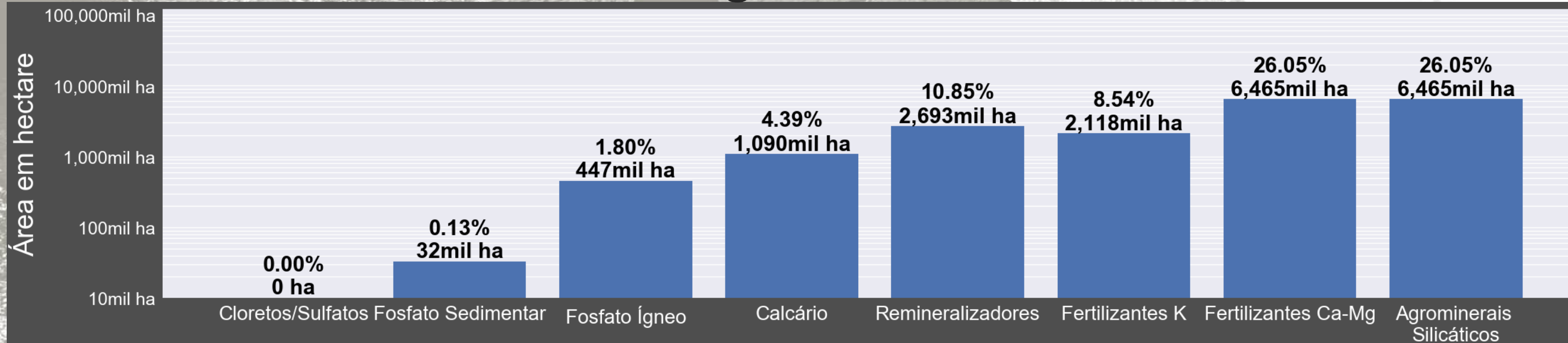
Fertilizantes Macronut. Essenciais

Fertilizantes Macronut. Secundários

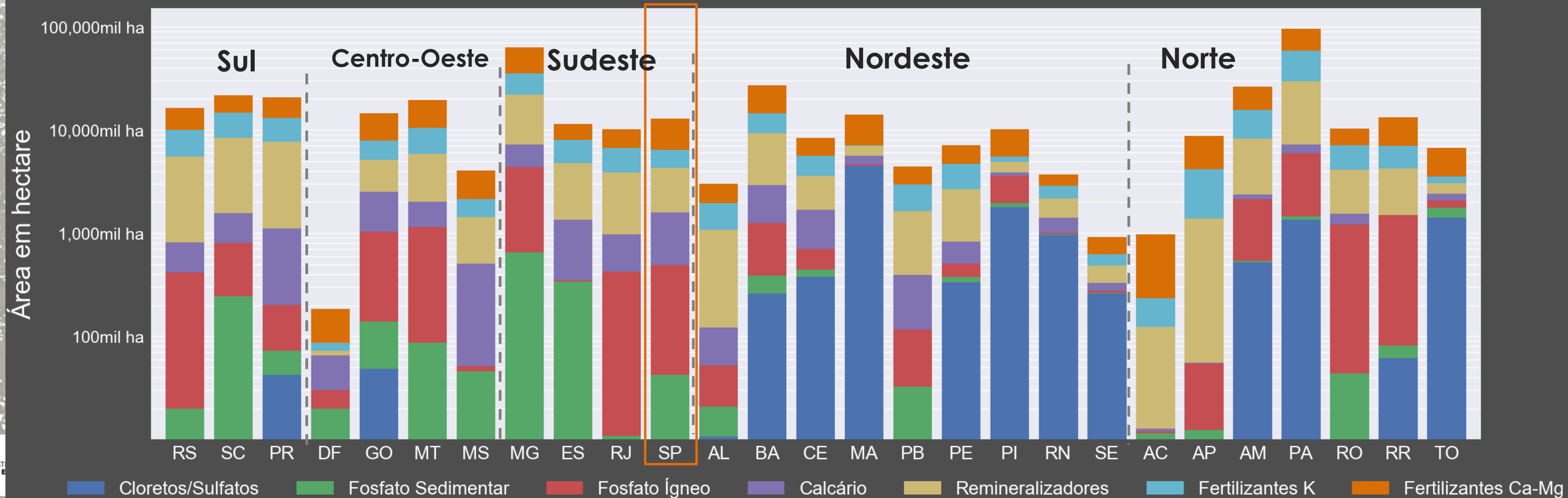




# Potencial de Ocorrência de Agrominerais - SP



Área Total com Potencial para Agrominerais no Brasil por Estado





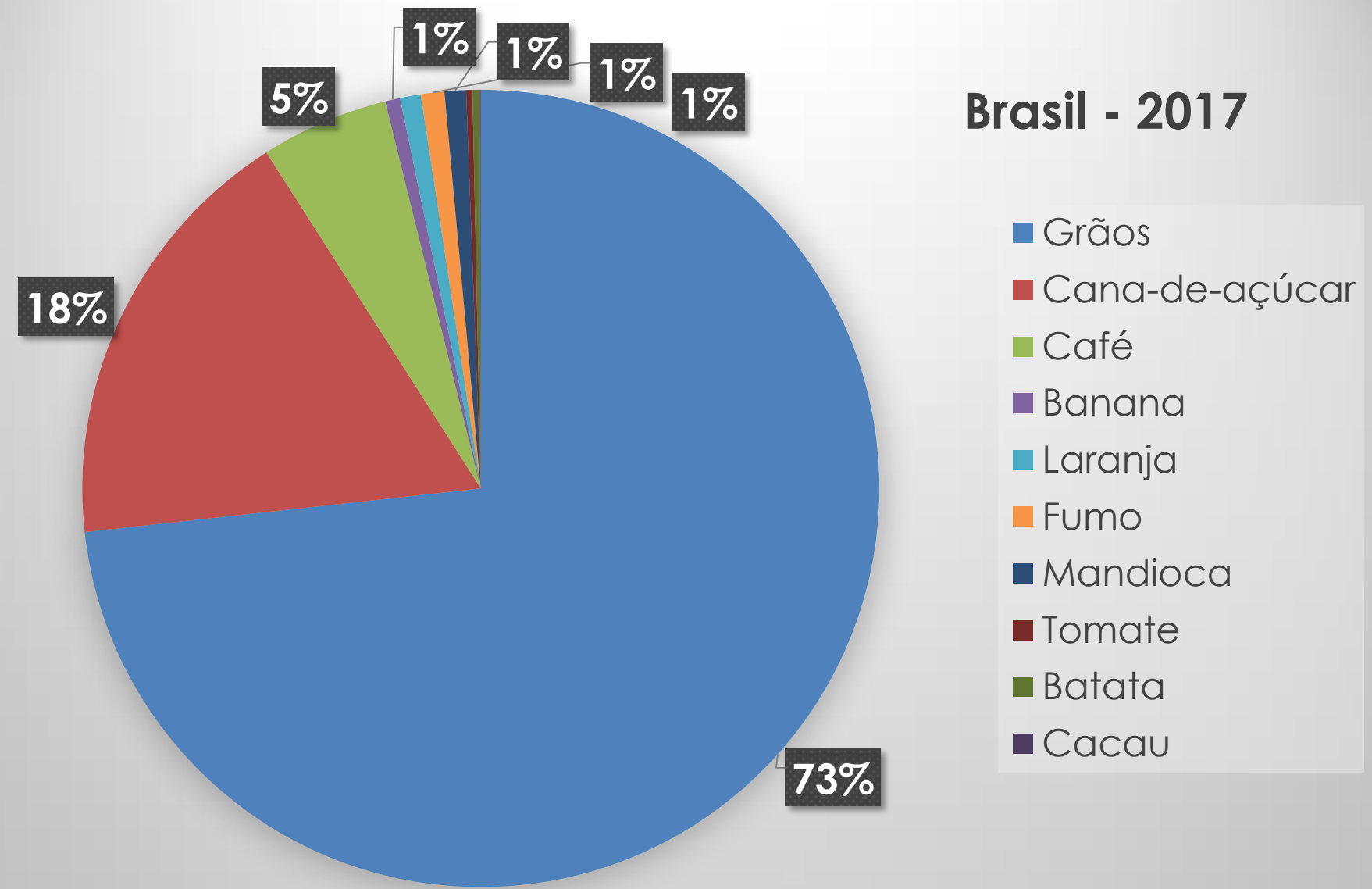
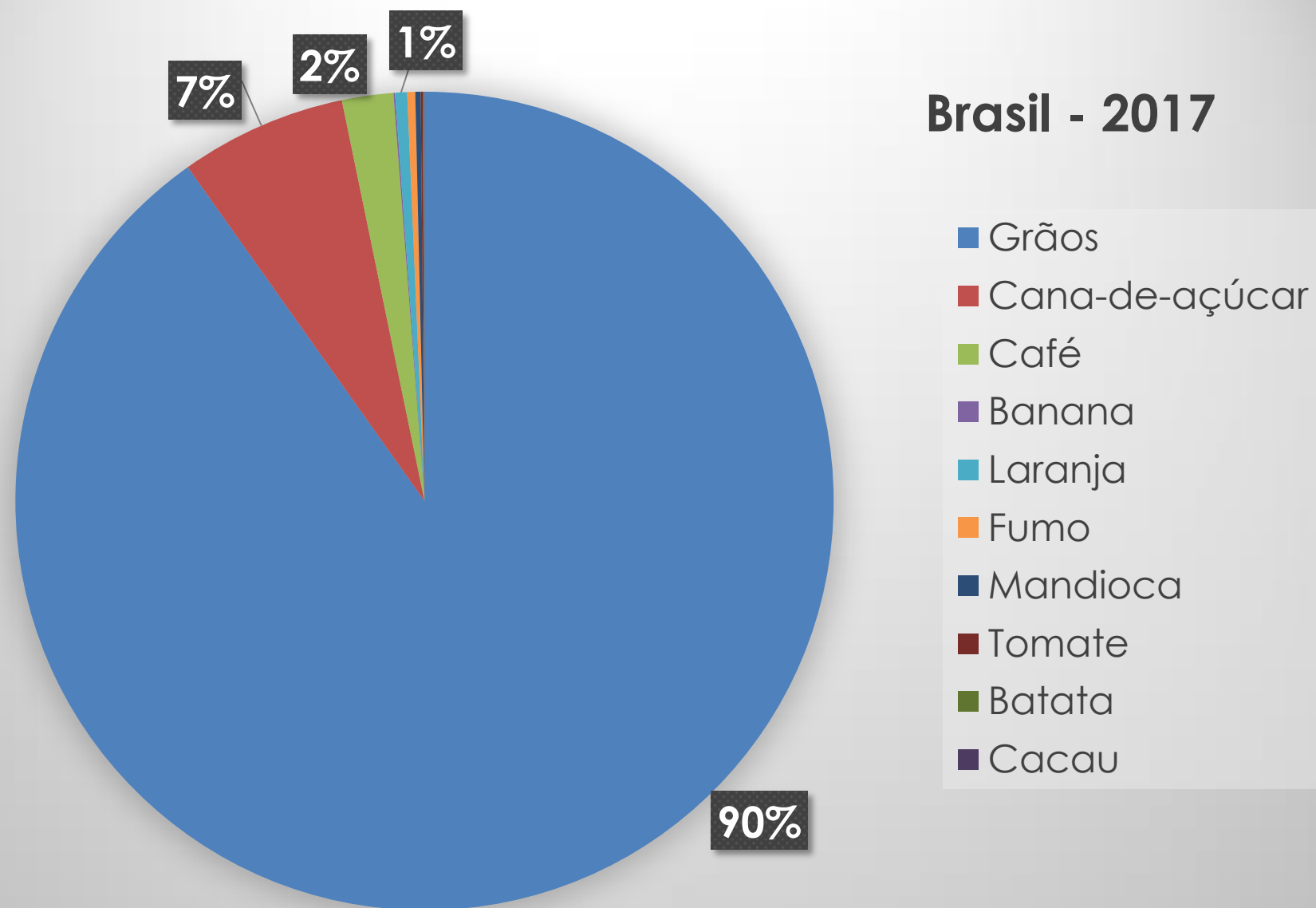
# Consumo de Nutrientes



# Consumo de nutrientes

Consumo  $P_2O_5$  (2017): 5,4 M de toneladas

Consumo  $K_2O$  (2017): 6,0 M de toneladas



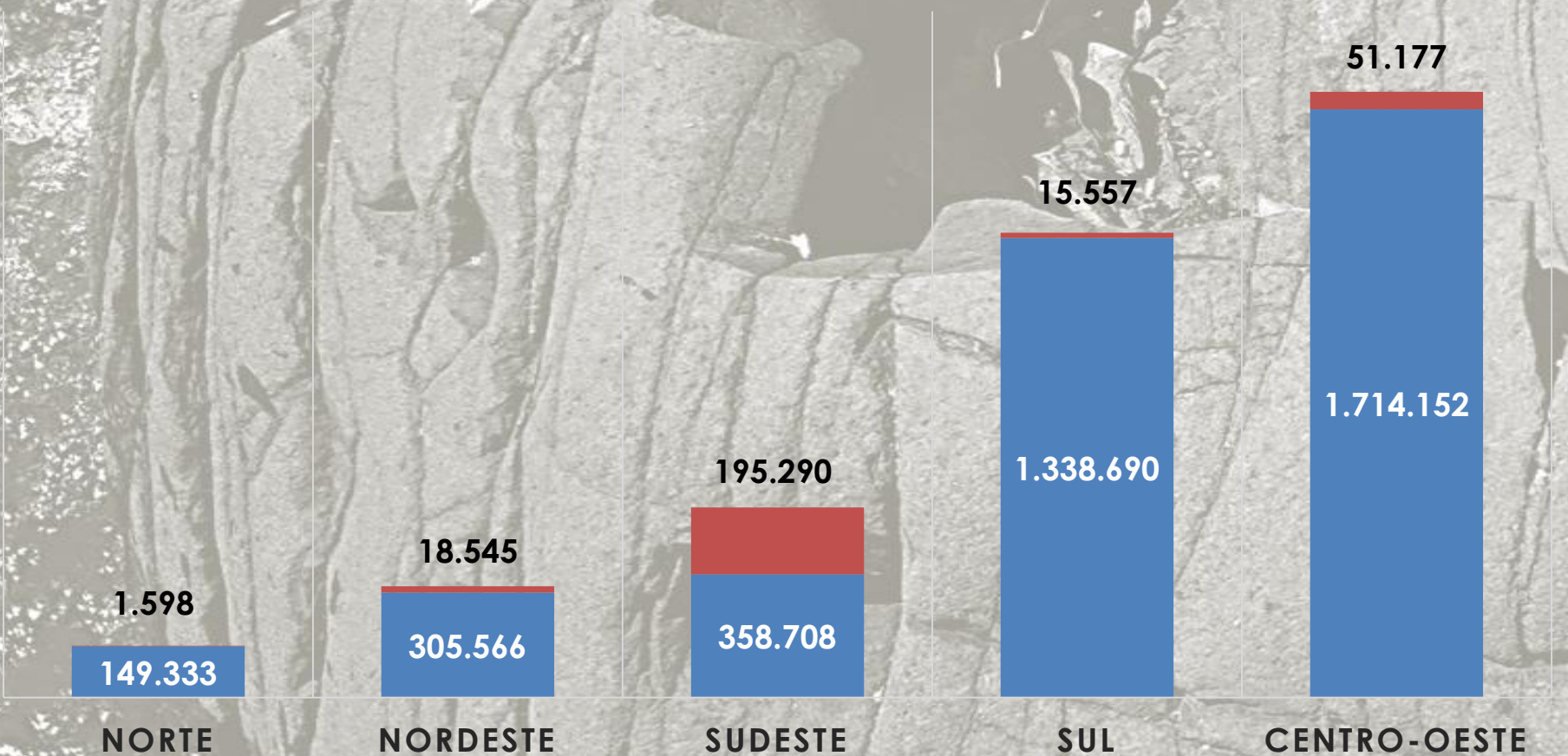
Fonte: Produção (IBGE); Taxas de consumo (Embrapa)



# Consumo de nutrientes

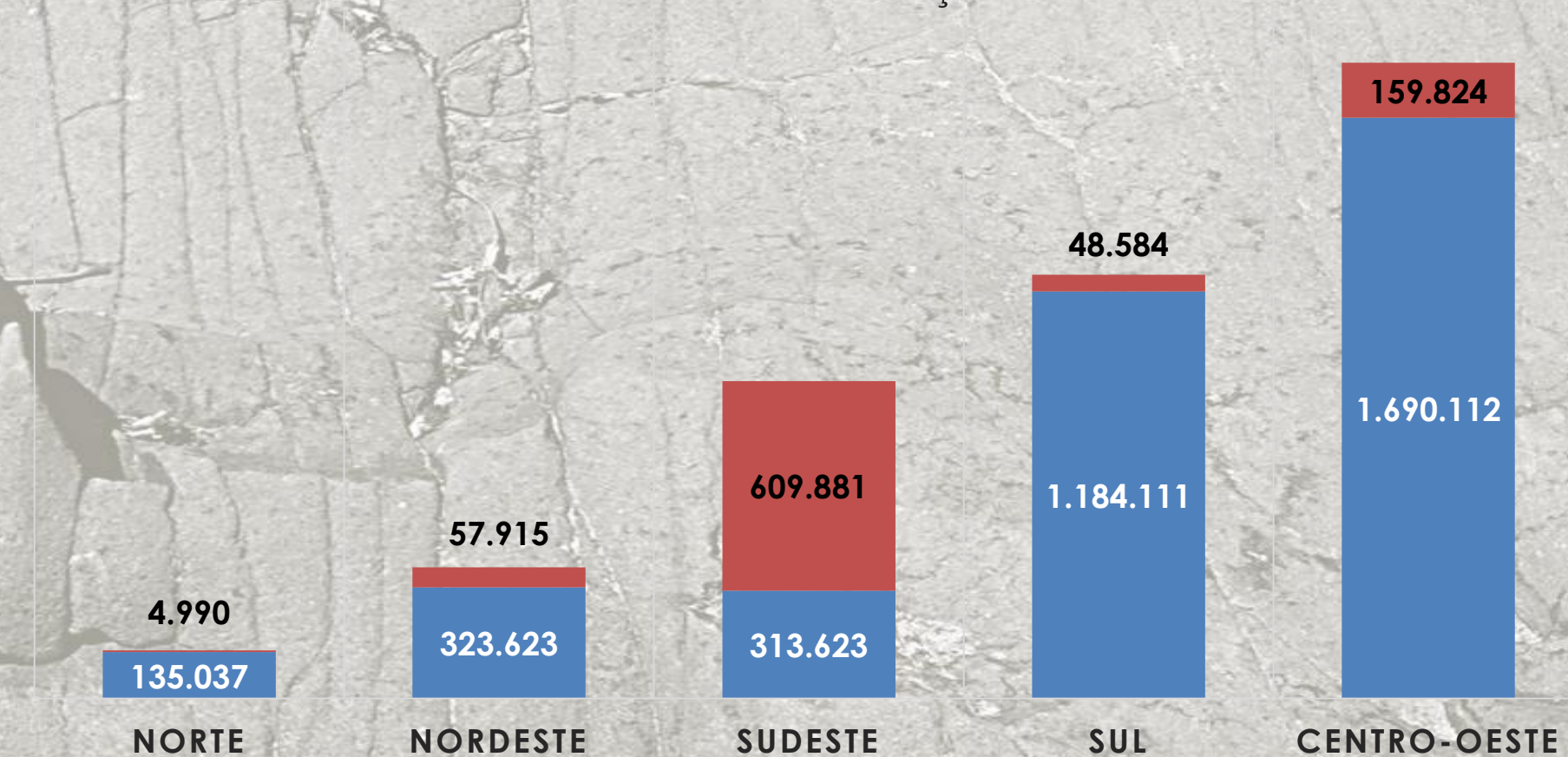
## CONSUMO DE P<sub>2</sub>O<sub>5</sub> (1.000 kg) - 2017

■ Grãos ■ Cana-de-açúcar



## CONSUMO DE K<sub>2</sub>O (1.000 kg) - 2017

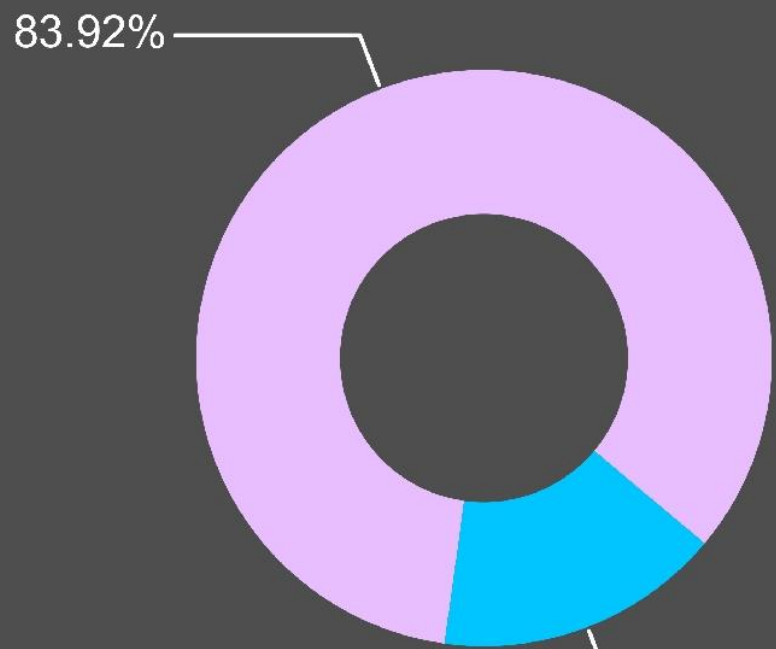
■ Grãos ■ Cana-de-açúcar



Fonte: Produção (IBGE); Taxas de consumo (Embrapa)

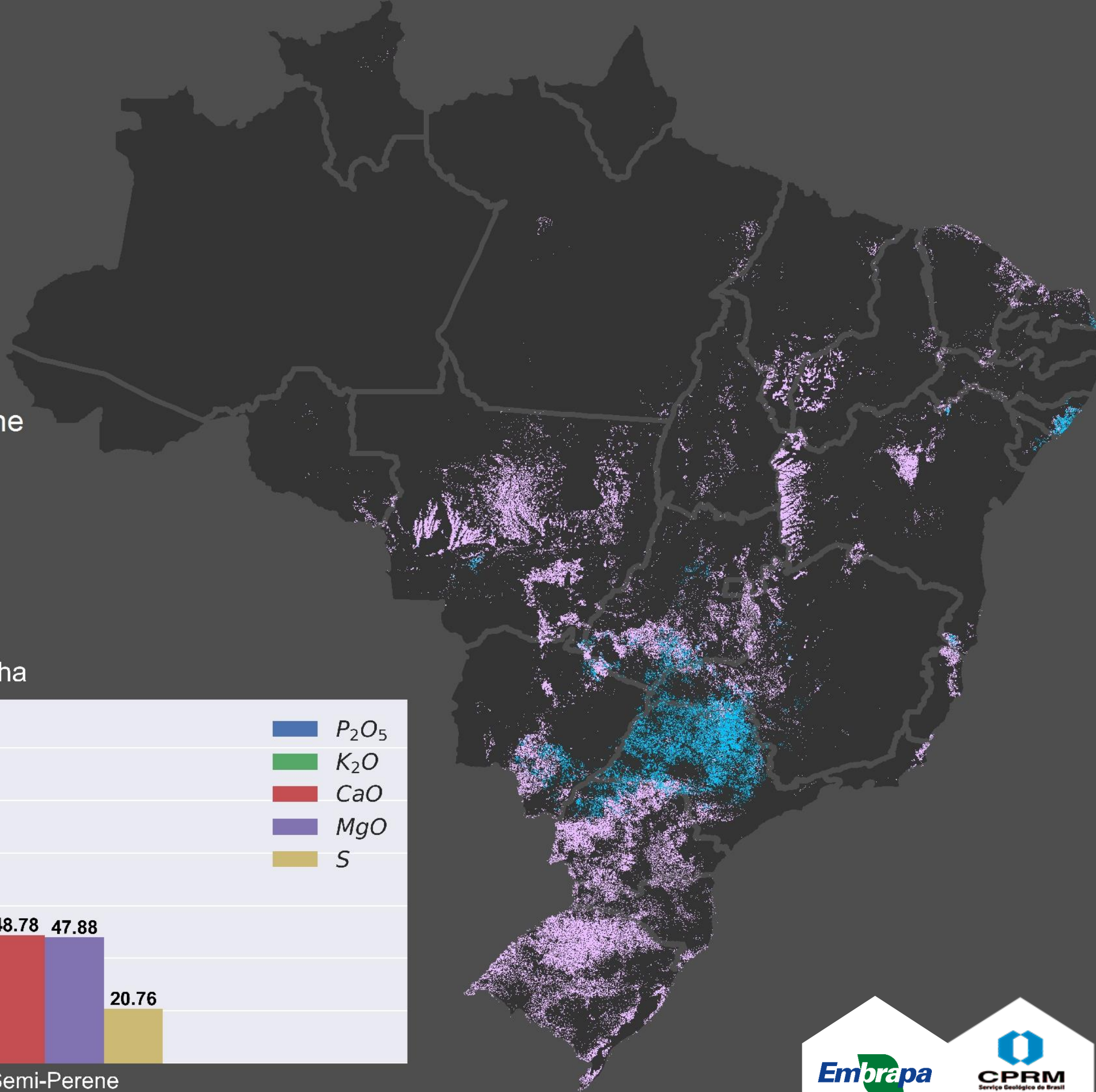


# Consumo de Nutrientes no Brasil 2017

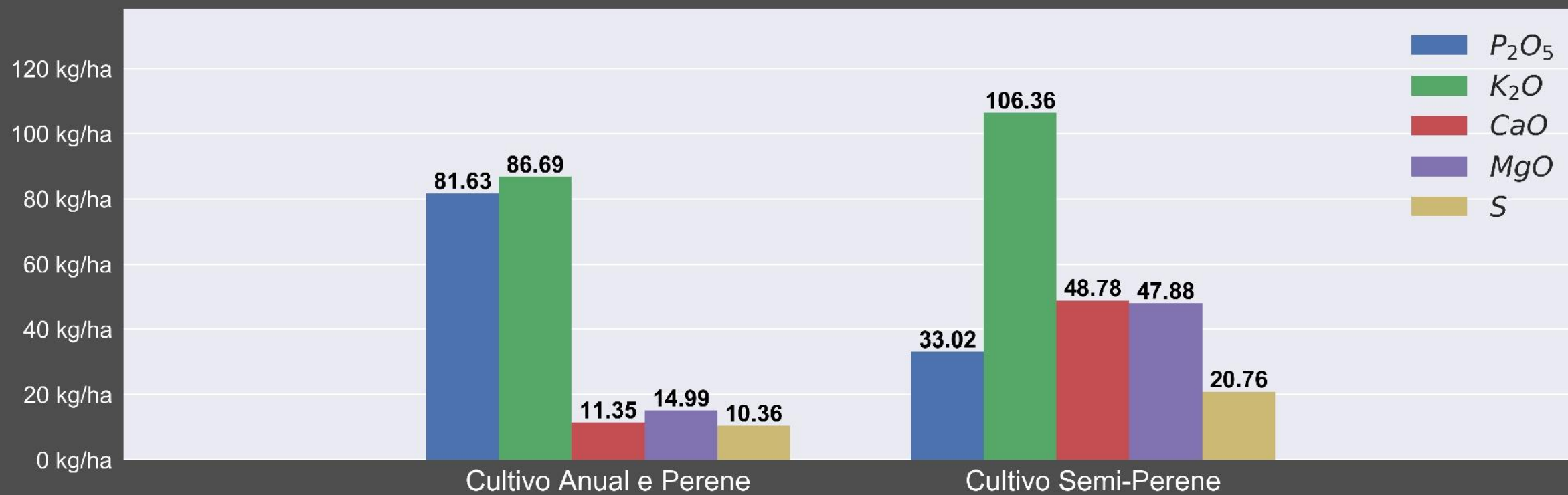


## Classes - Mapbiomas

- Cultivo Anual e Perene
- Cultivo Semi-Perene

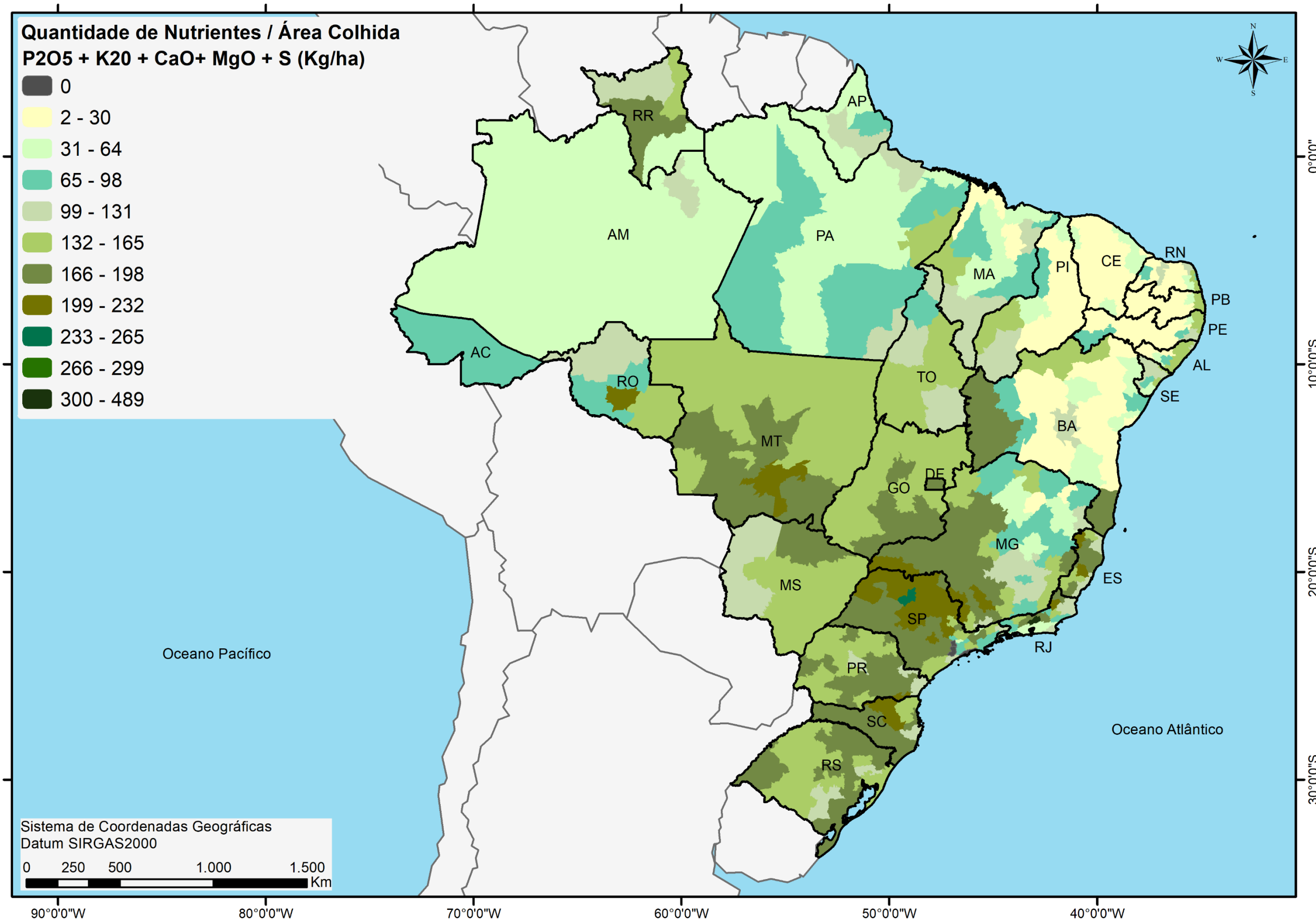


## Consumo de Nutrientes em Kg/ha





# Consumo de nutrientes (kg/ha) recomendação de uso - Brasil





# Integração Consumo/Oferta

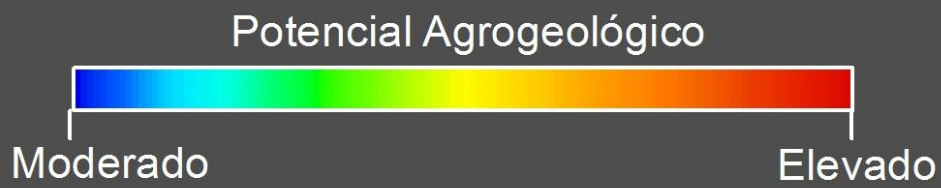
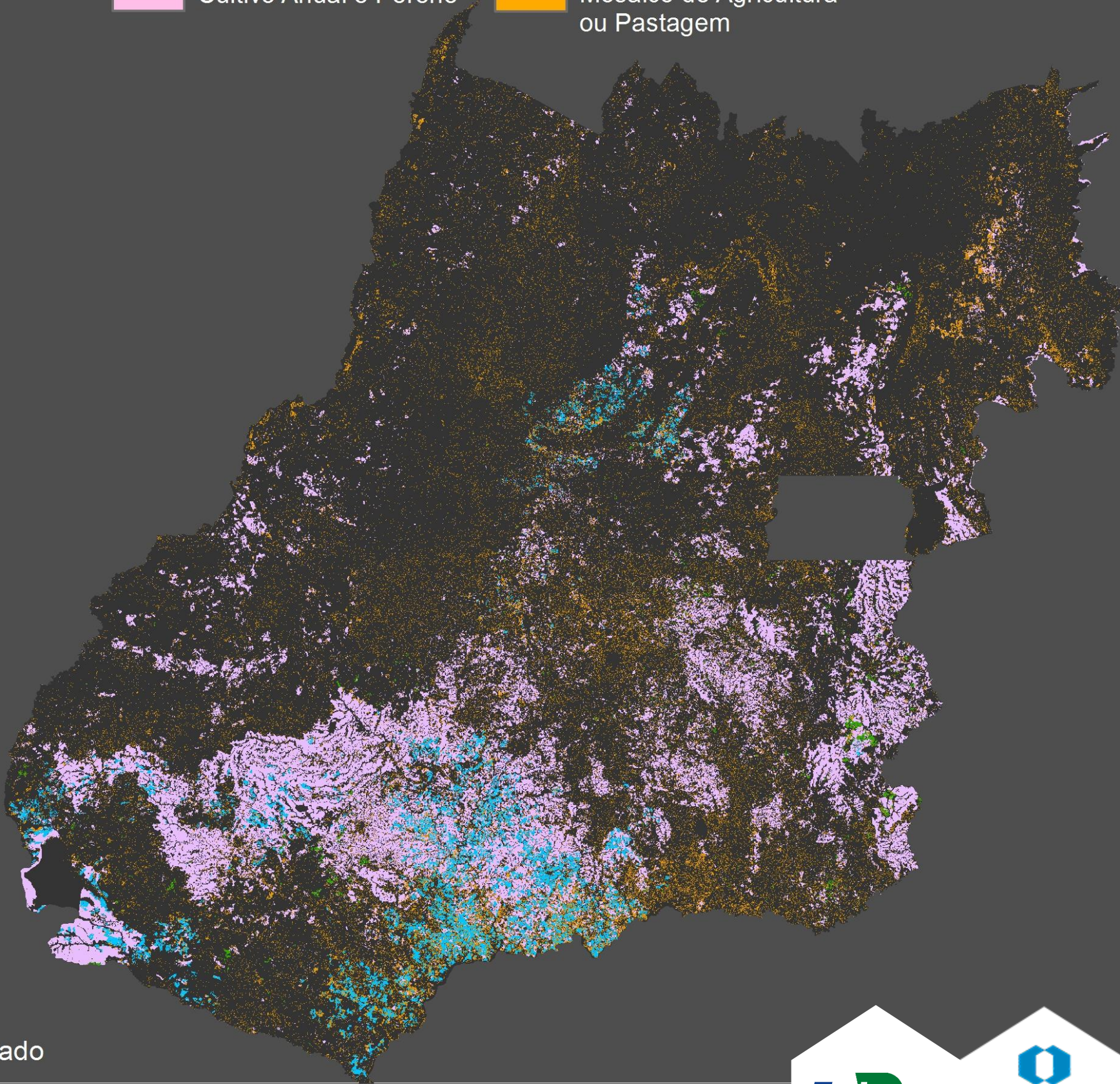
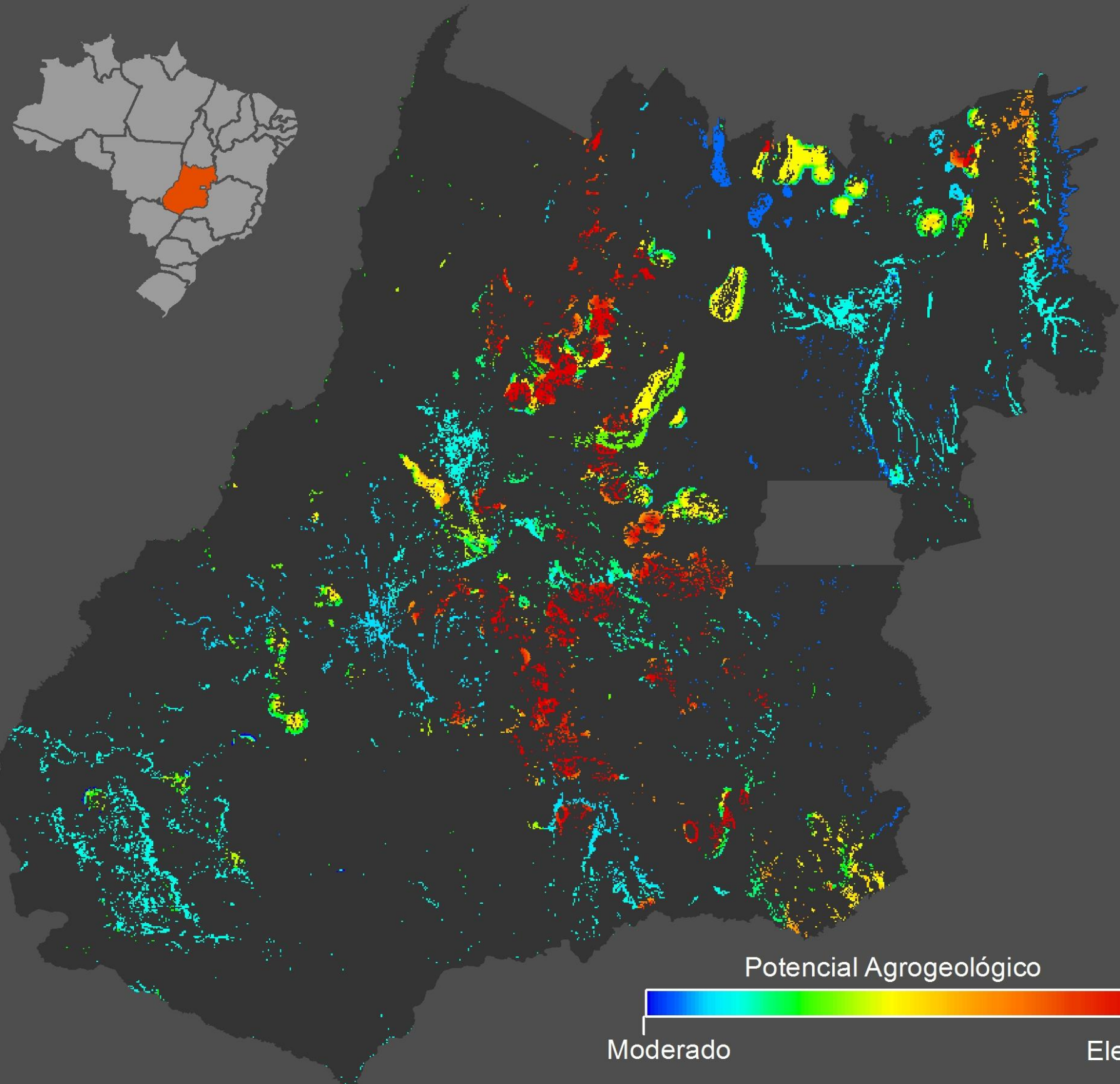


# Consumo/Oferta de Agrominerais - GO

## Remineralizadores

### Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem





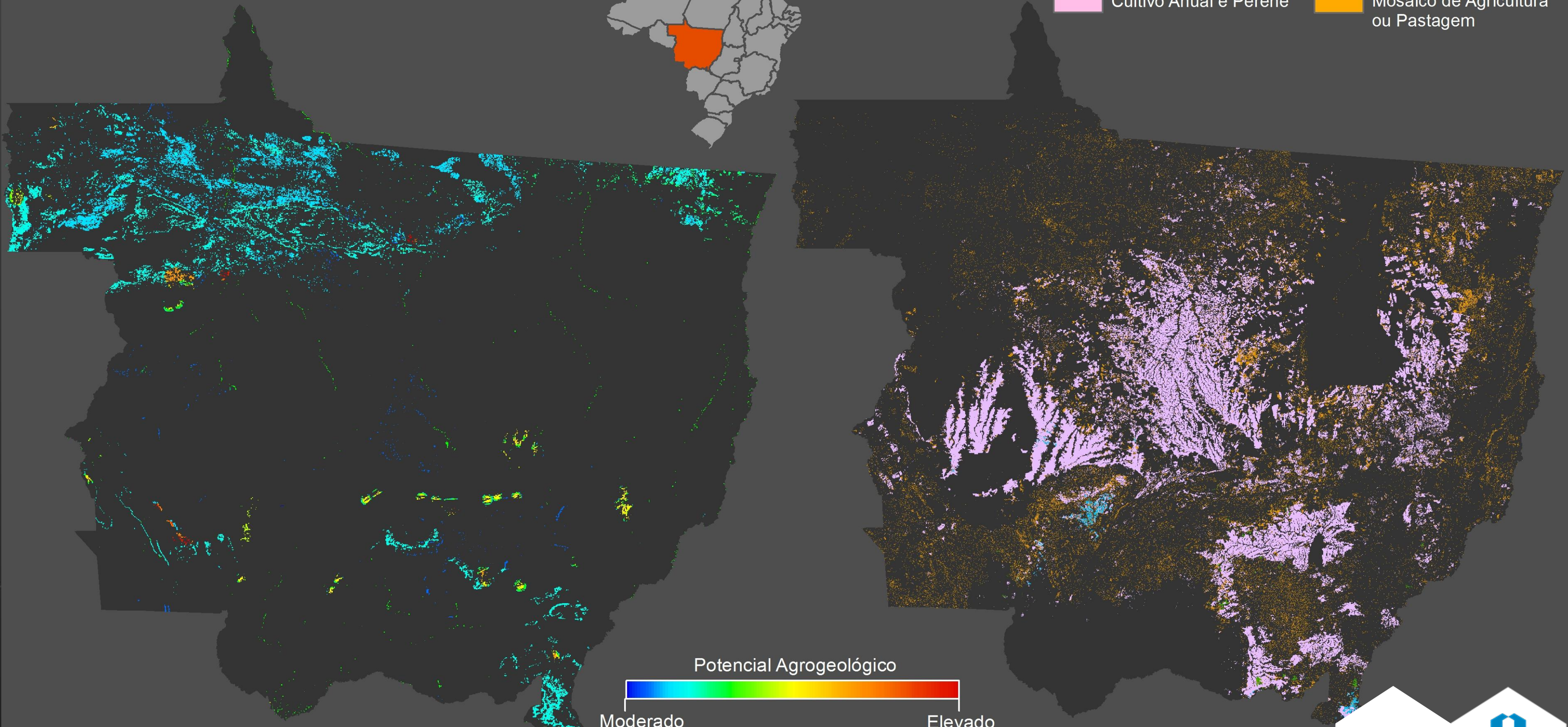
# Consumo/Oferita de Agrominerais - MT

## Remineralizadores



### Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem



Potencial Agrogeológico

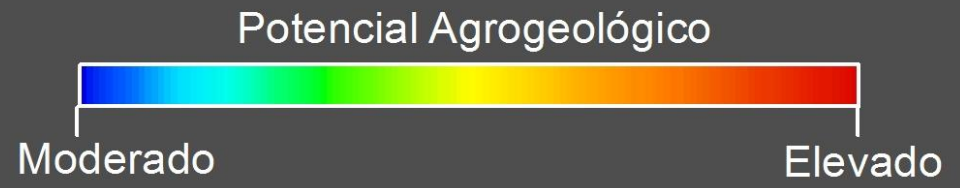
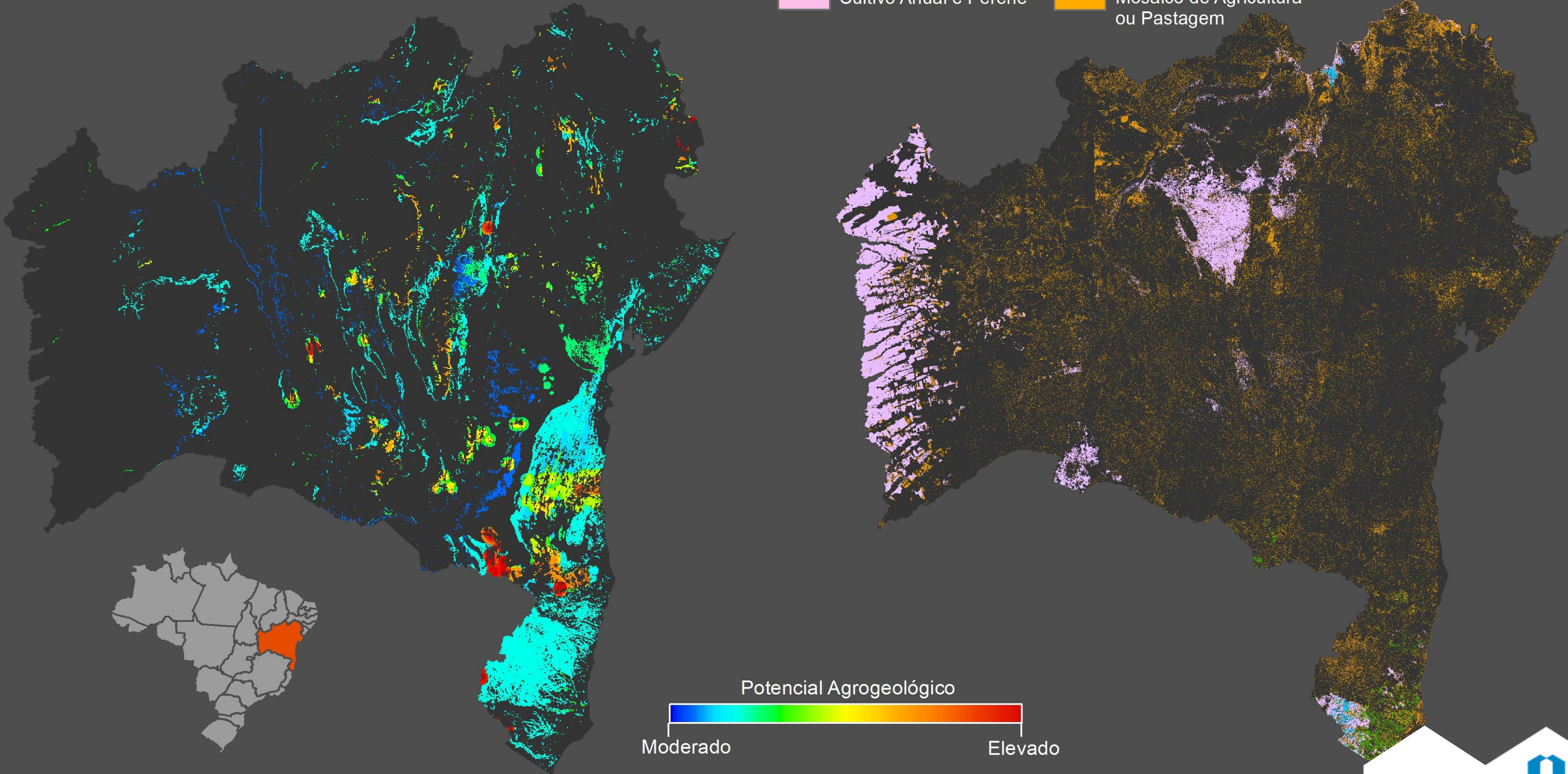




# Consumo/Oferta de Agrominerais - BA Remineralizadores

## Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem



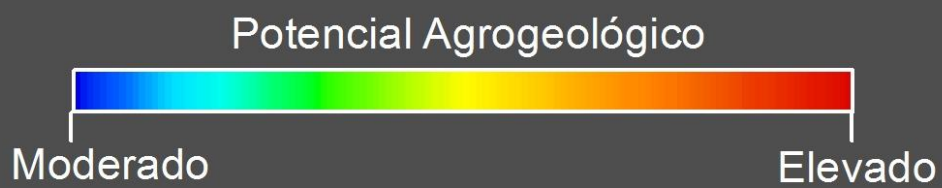
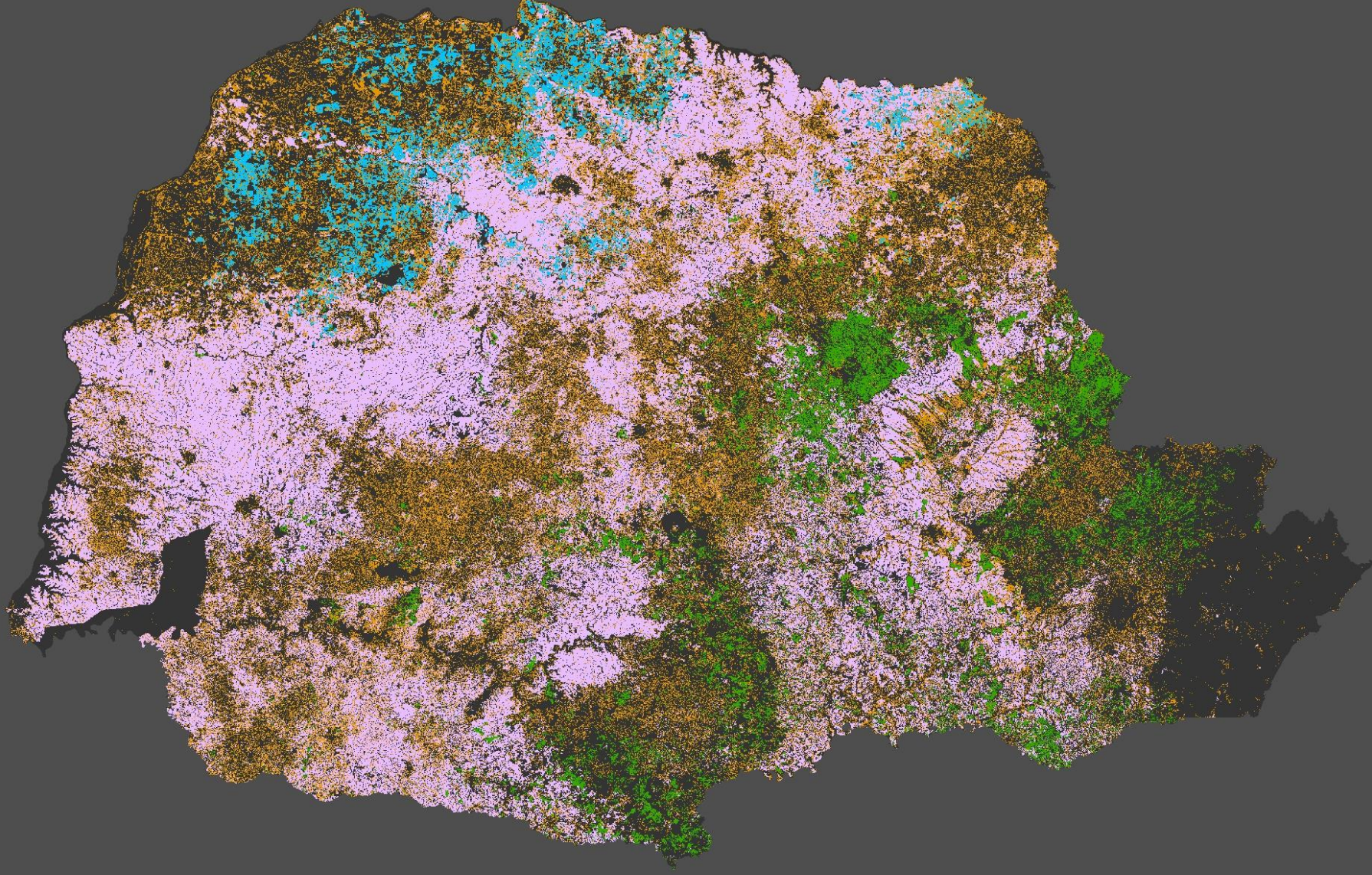
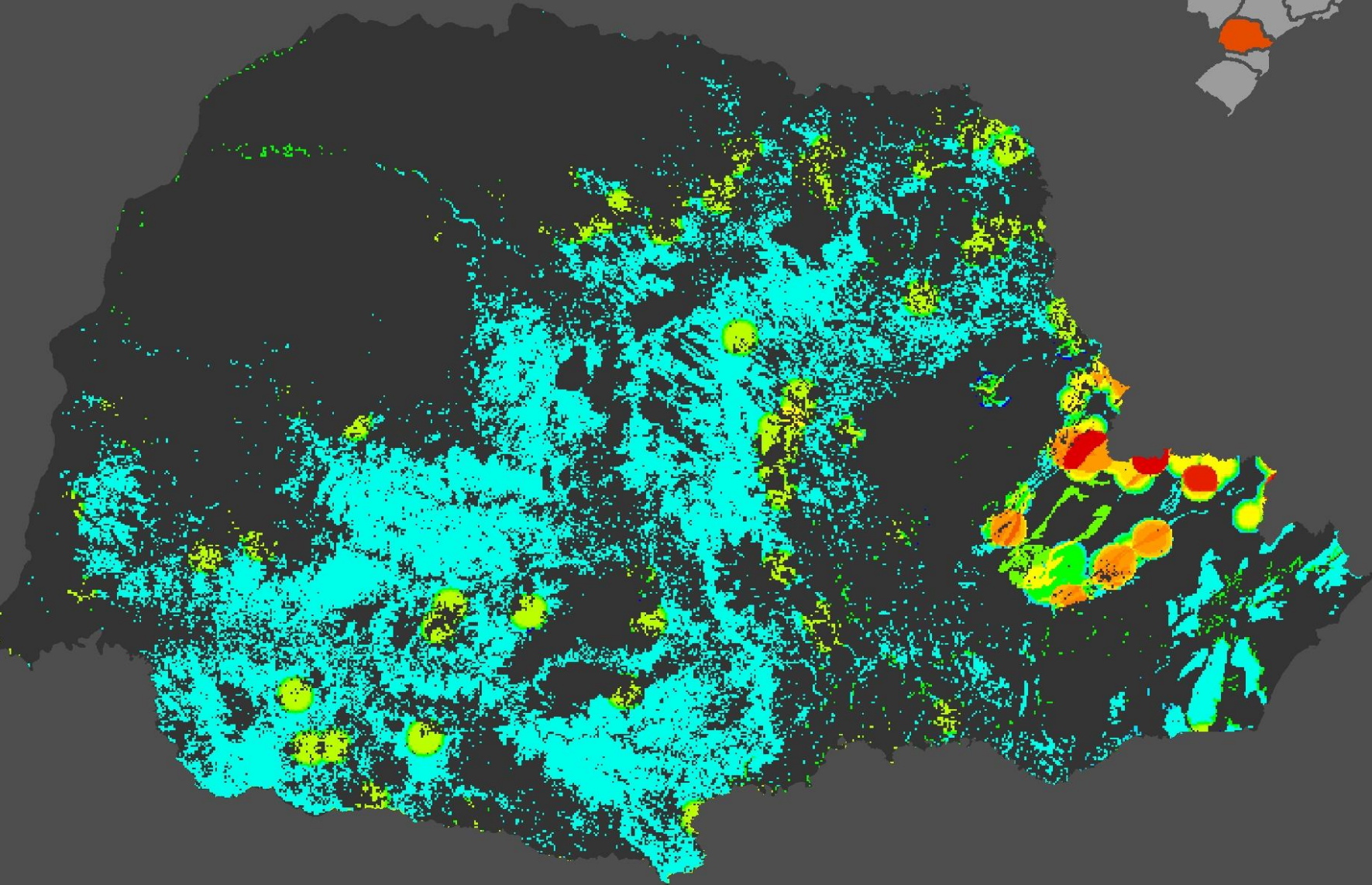


# Consumo/Oferta de Agrominerais - PR Remineralizadores



### Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem





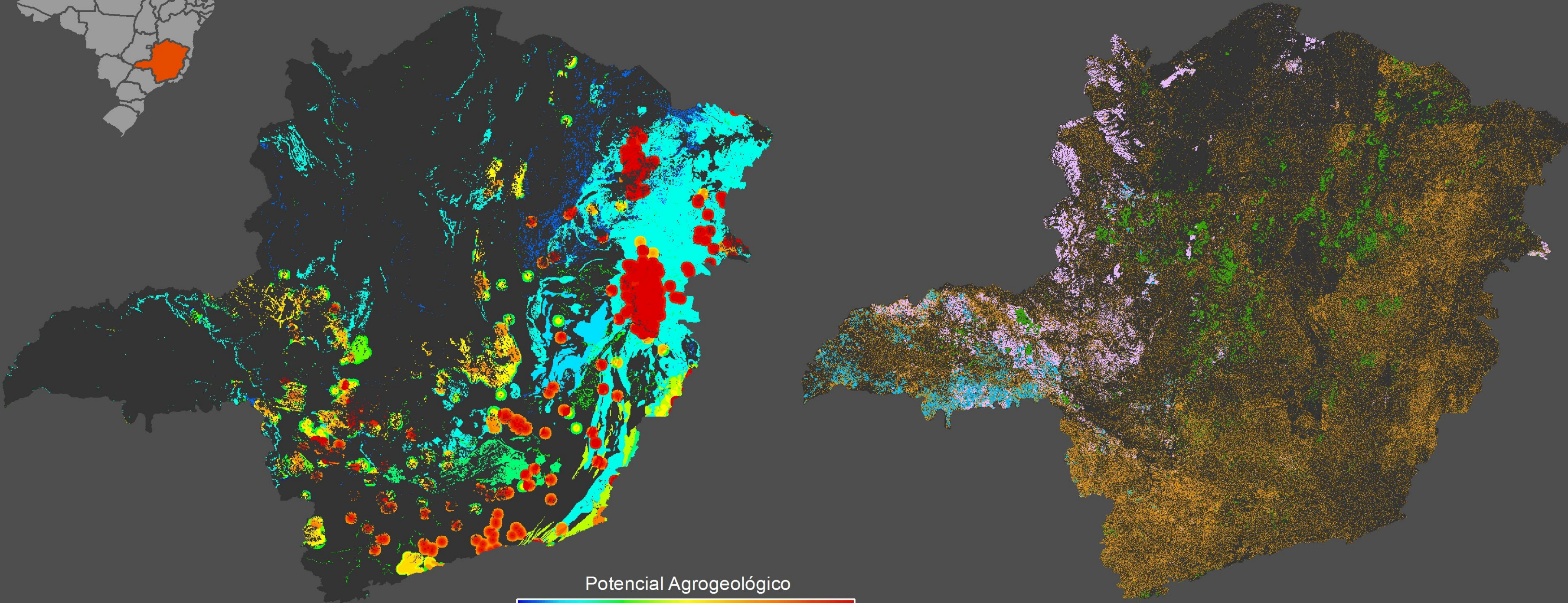
# Consumo/Oferta de Agrominerais - MG

## Remineralizadores



### Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem



Potencial Agrogeológico

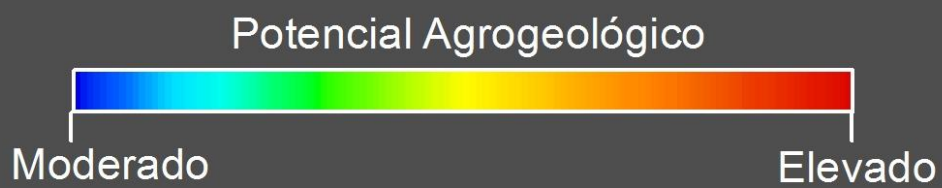
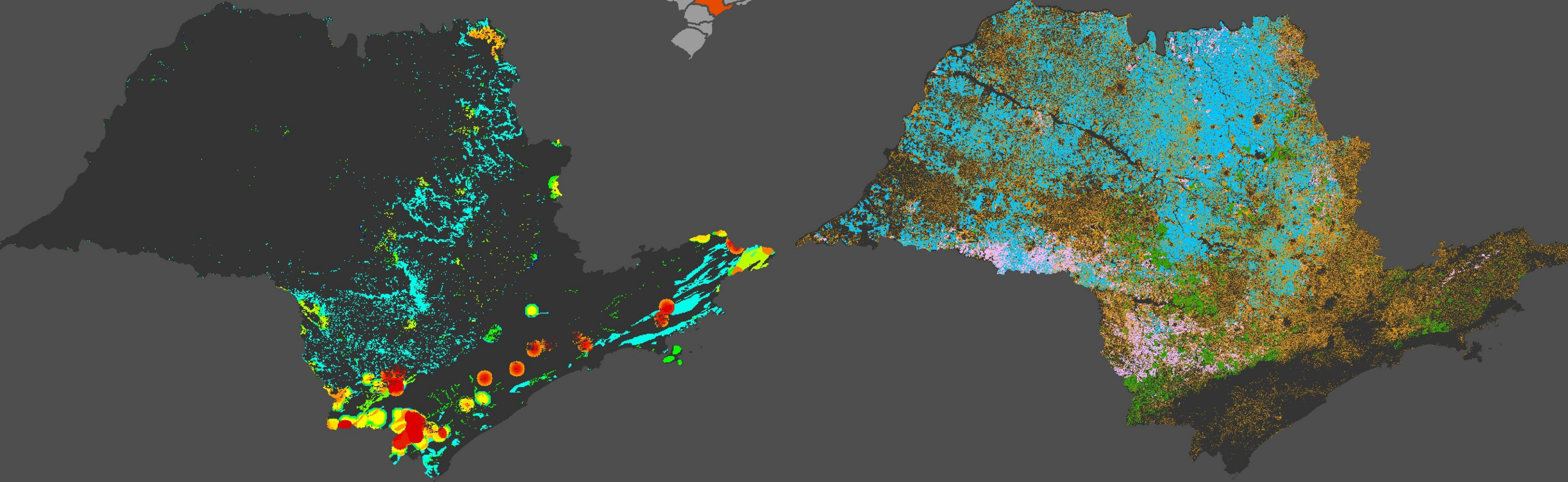




# Consumo/Oferta de Agrominerais - SP Remineralizadores

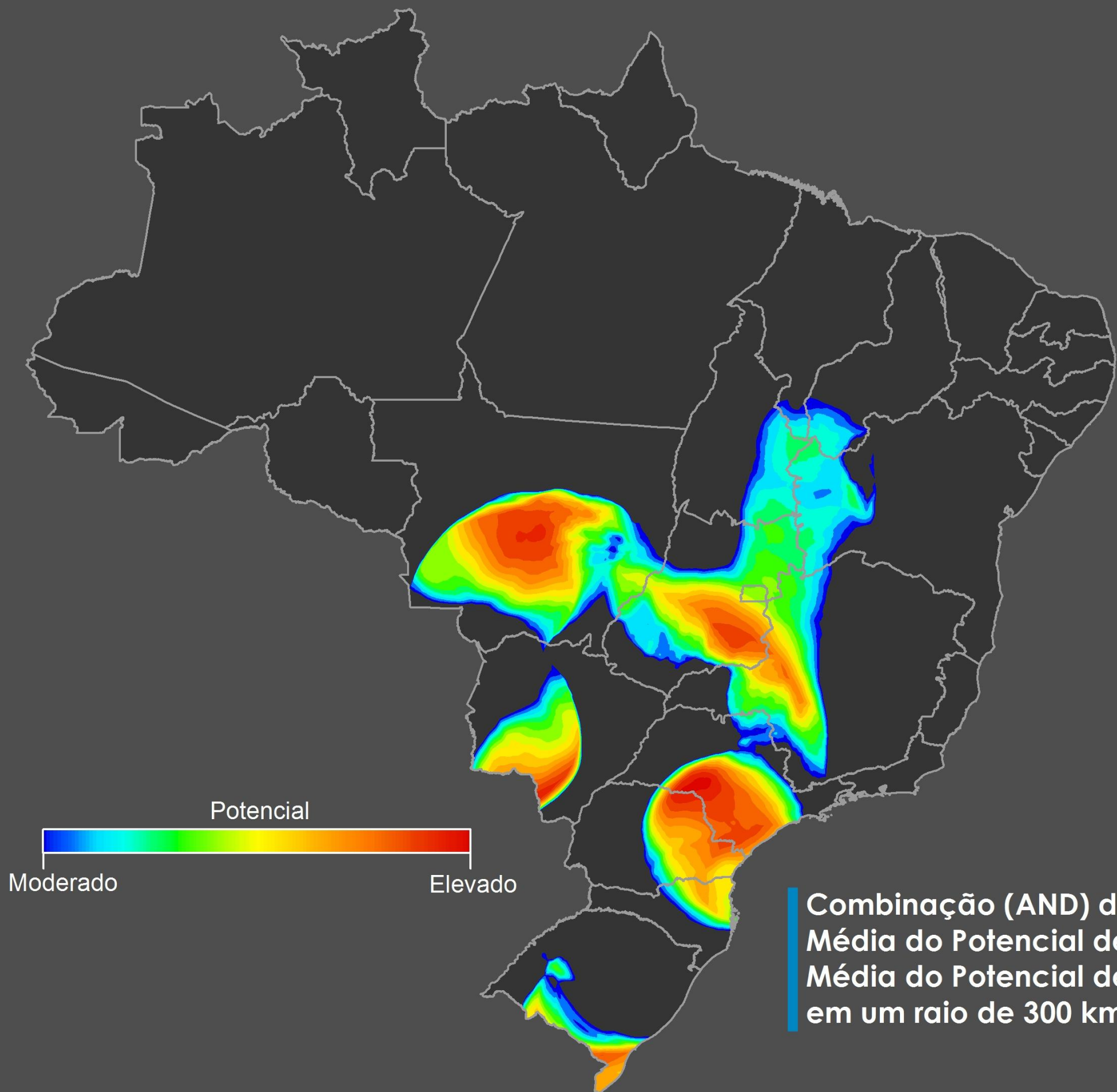
## Classes - Mapbiomas

-  Silvicultura
-  Cultivo Anual e Perene
-  Cultivo Semi-Perene
-  Mosaico de Agricultura ou Pastagem





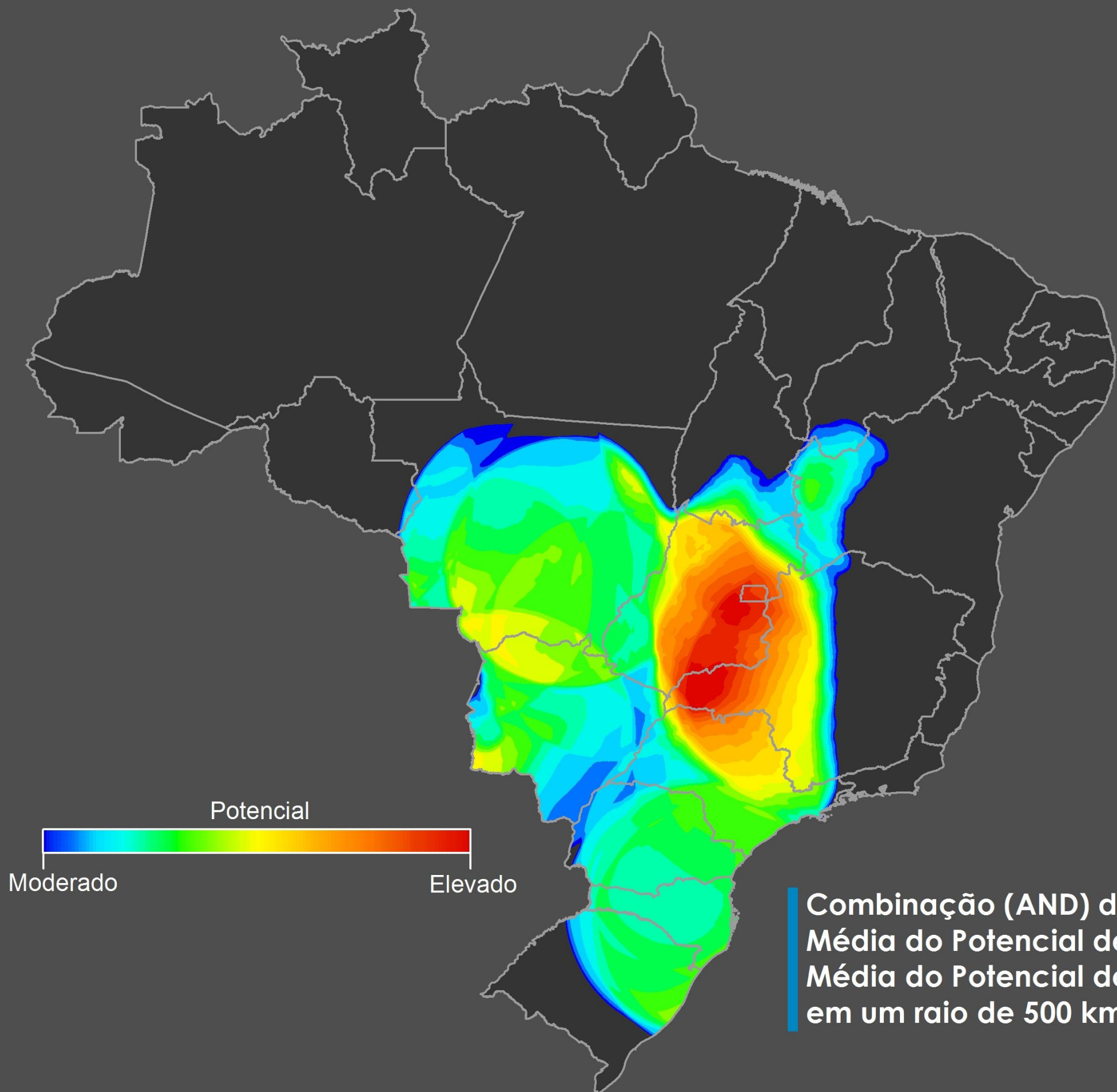
# Potencial Econômico para Carbonatos



Combinação (AND) da Média do Potencial de Oferta e Média do Potencial de Consumo em um raio de 300 km



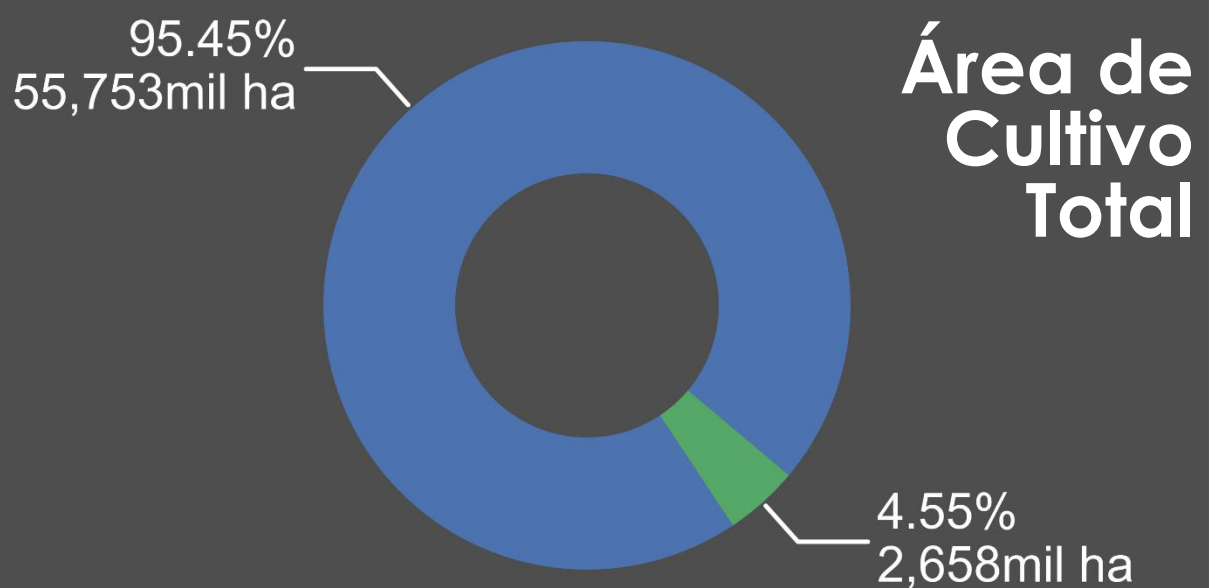
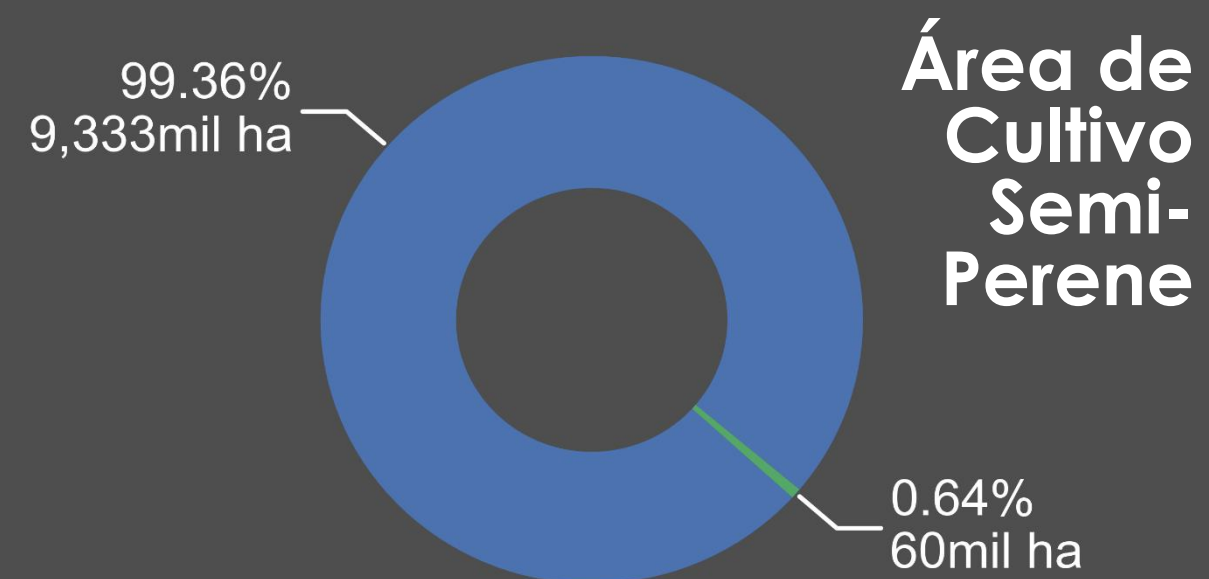
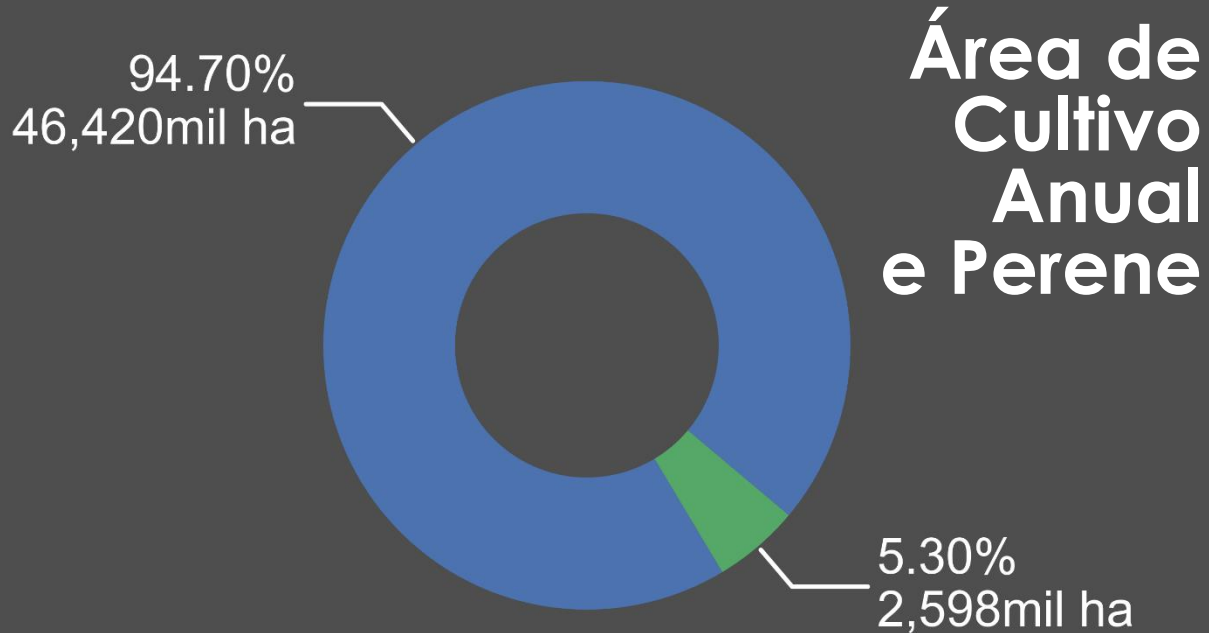
# Potencial Econômico para Fosfato Sedimentar



Combinação (AND) da Média do Potencial de Oferta e Média do Potencial de Consumo em um raio de 500 km

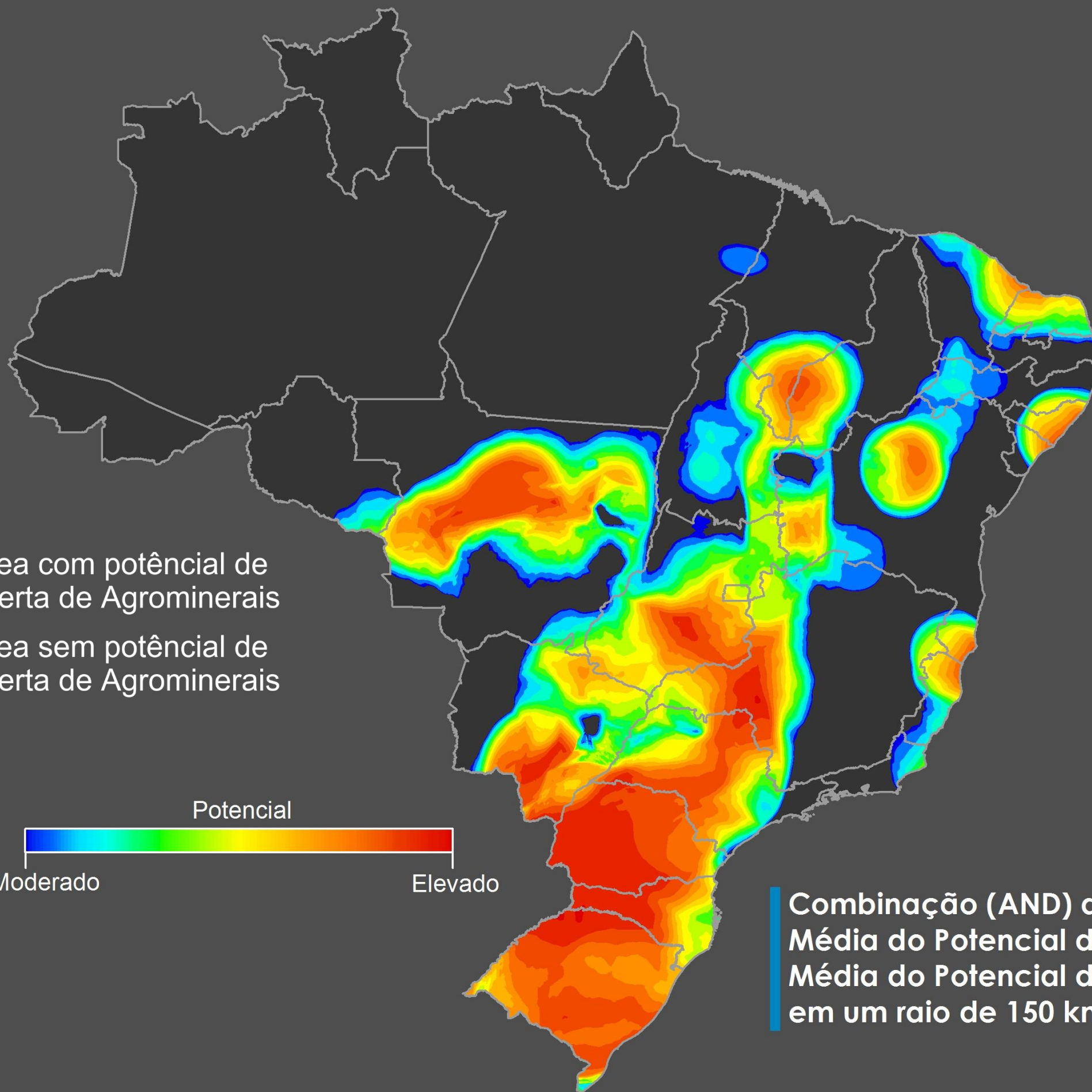
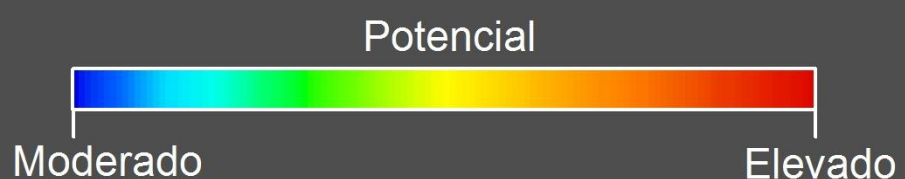


# Potencial Econômico para Agrominerais Silicáticos



Área com potencial de Oferta de Agrominerais

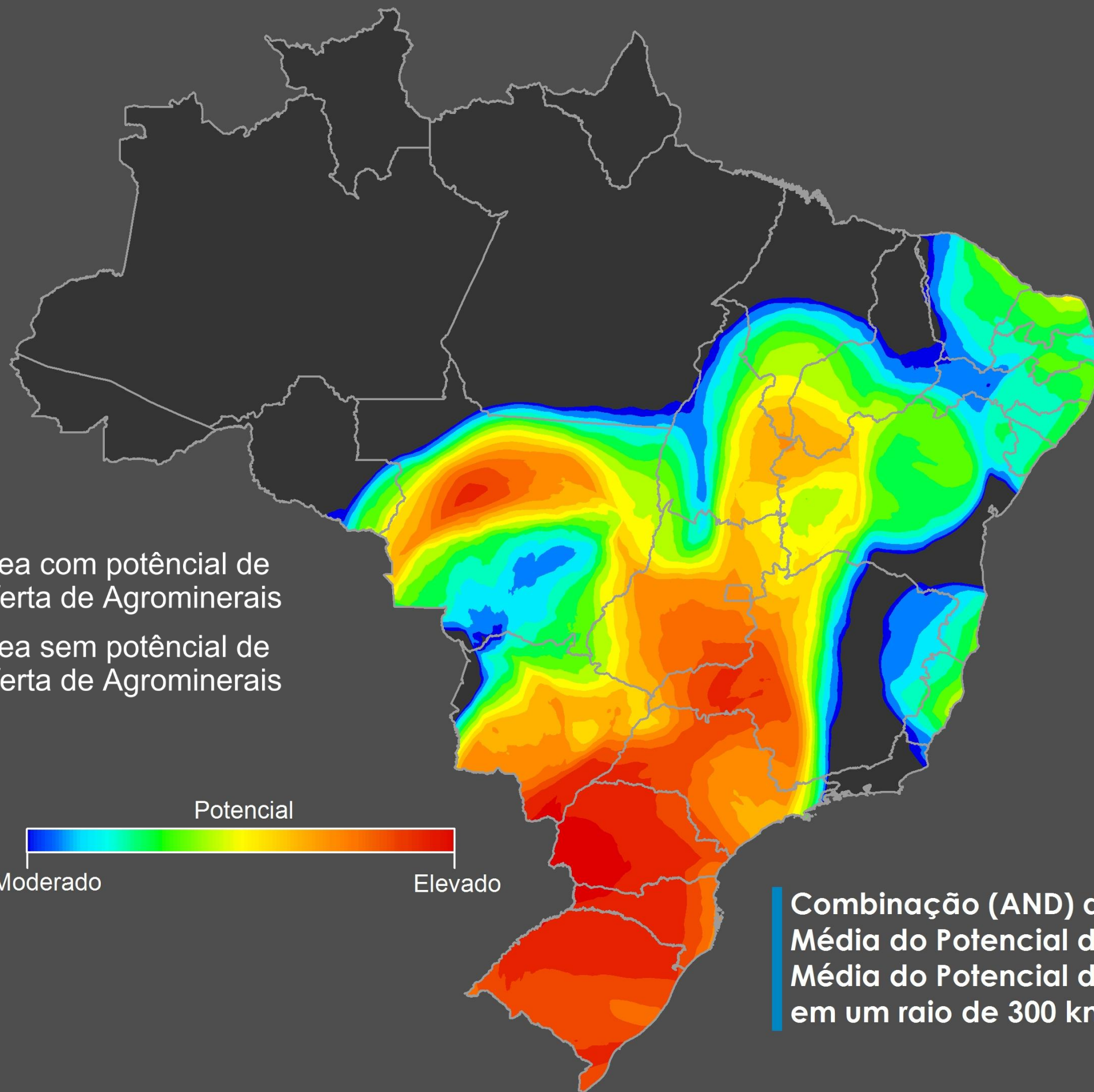
Área sem potencial de Oferta de Agrominerais



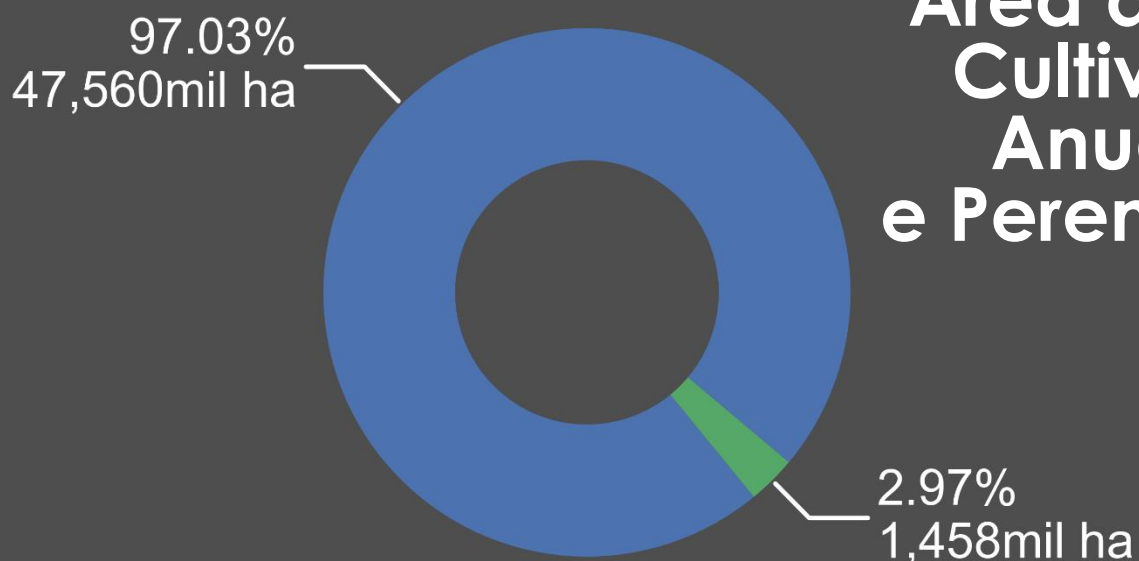
Combinação (AND) da Média do Potencial de Oferta e Média do Potencial de Consumo em um raio de 150 km



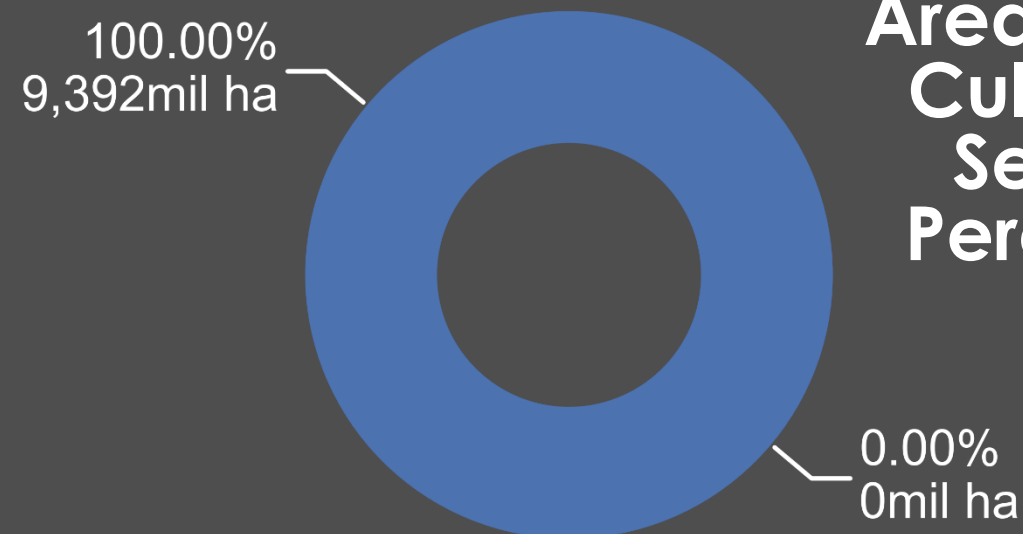
# Potencial Econômico para Agrominerais Silicáticos



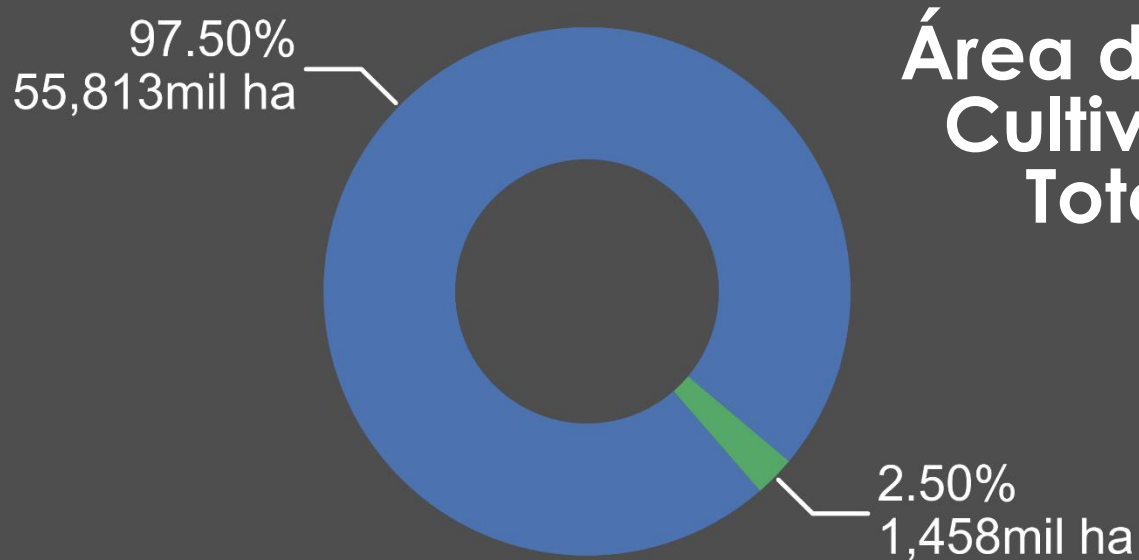
## Área de Cultivo Anual e Perene



## Área de Cultivo Semi-Perene

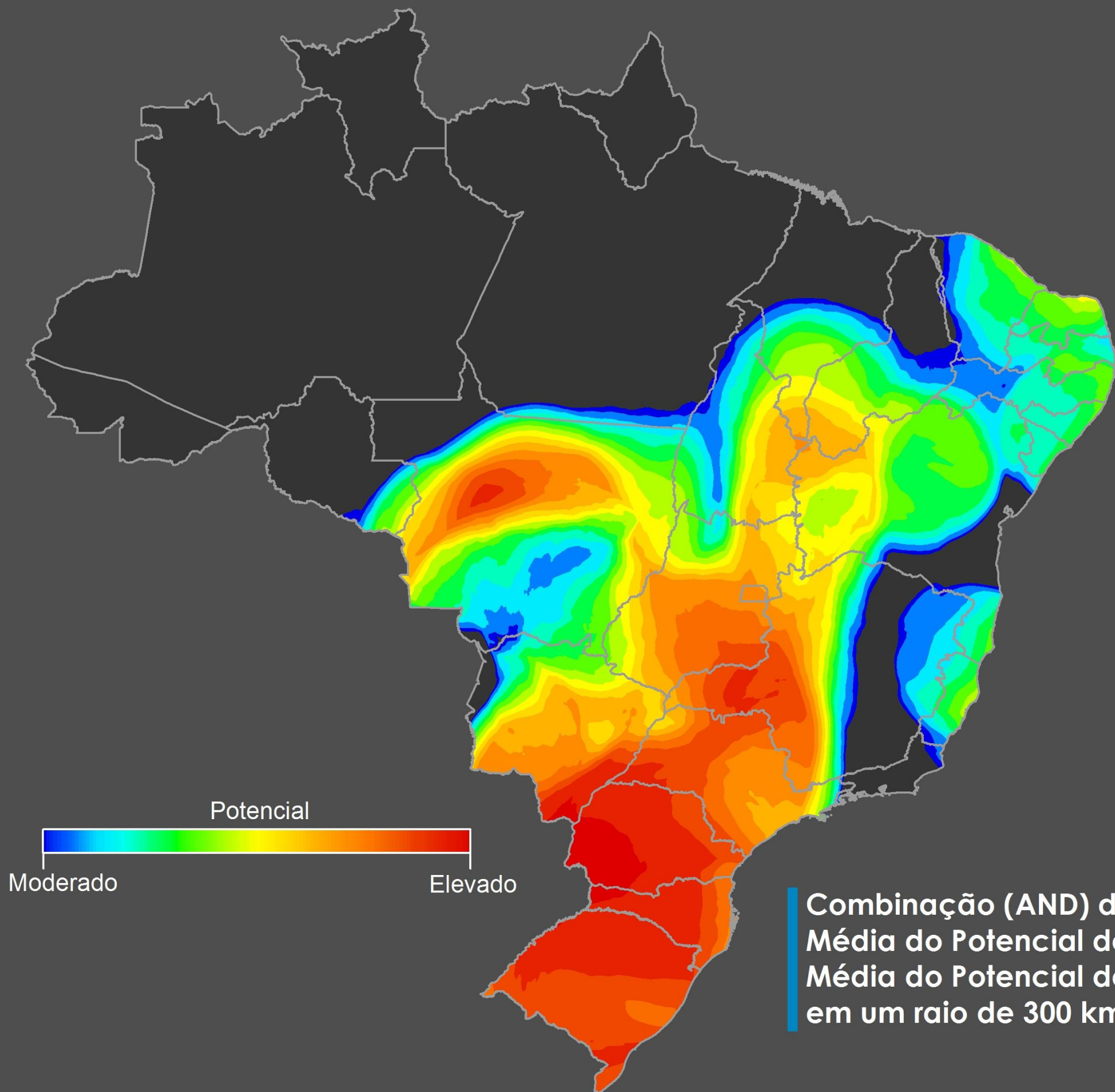


## Área de Cultivo Total





# Potencial Econômico para Agrominerais Silicáticos

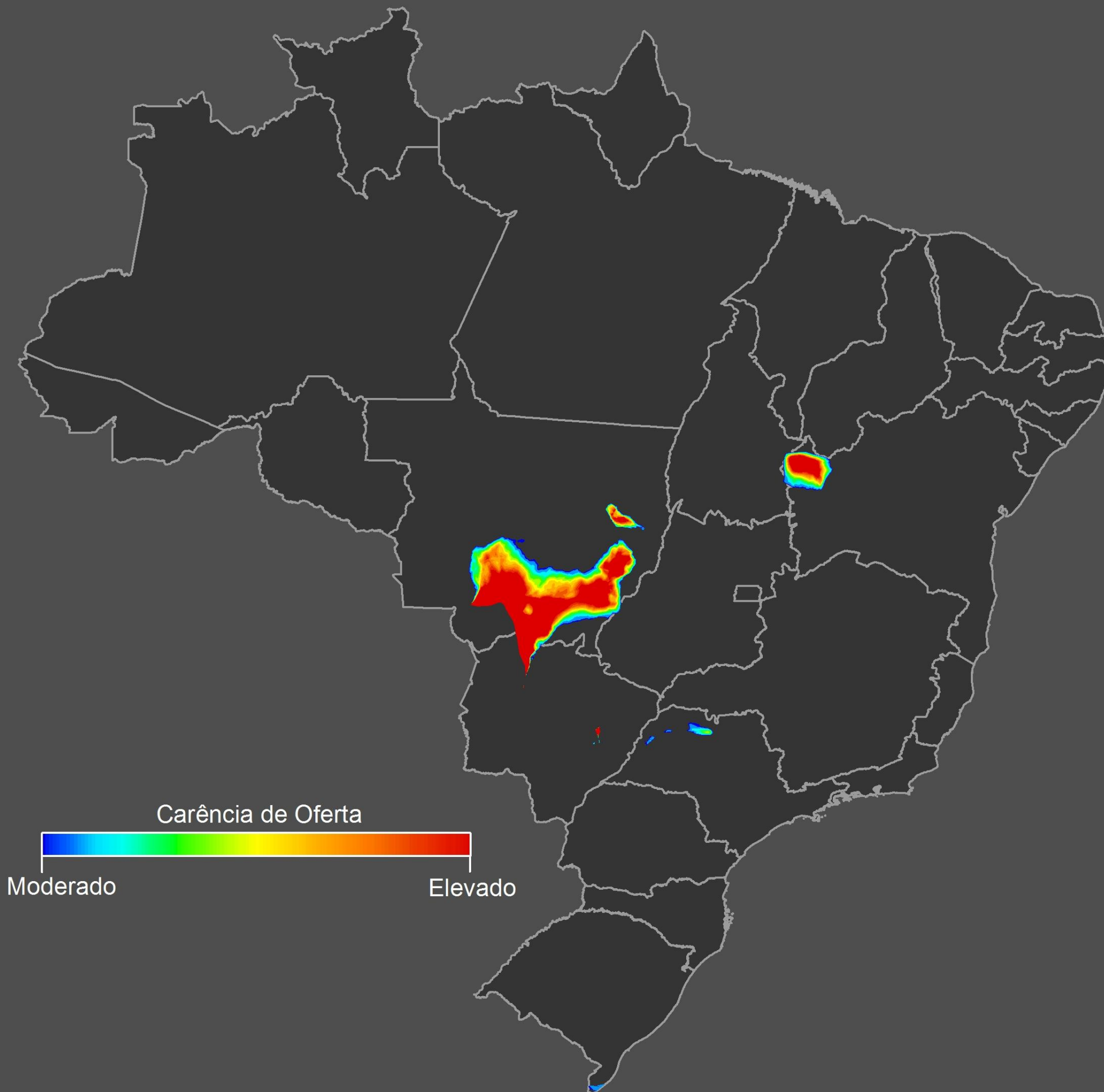




# Carência de Oferta para Agrominerais Silicáticos

150 km

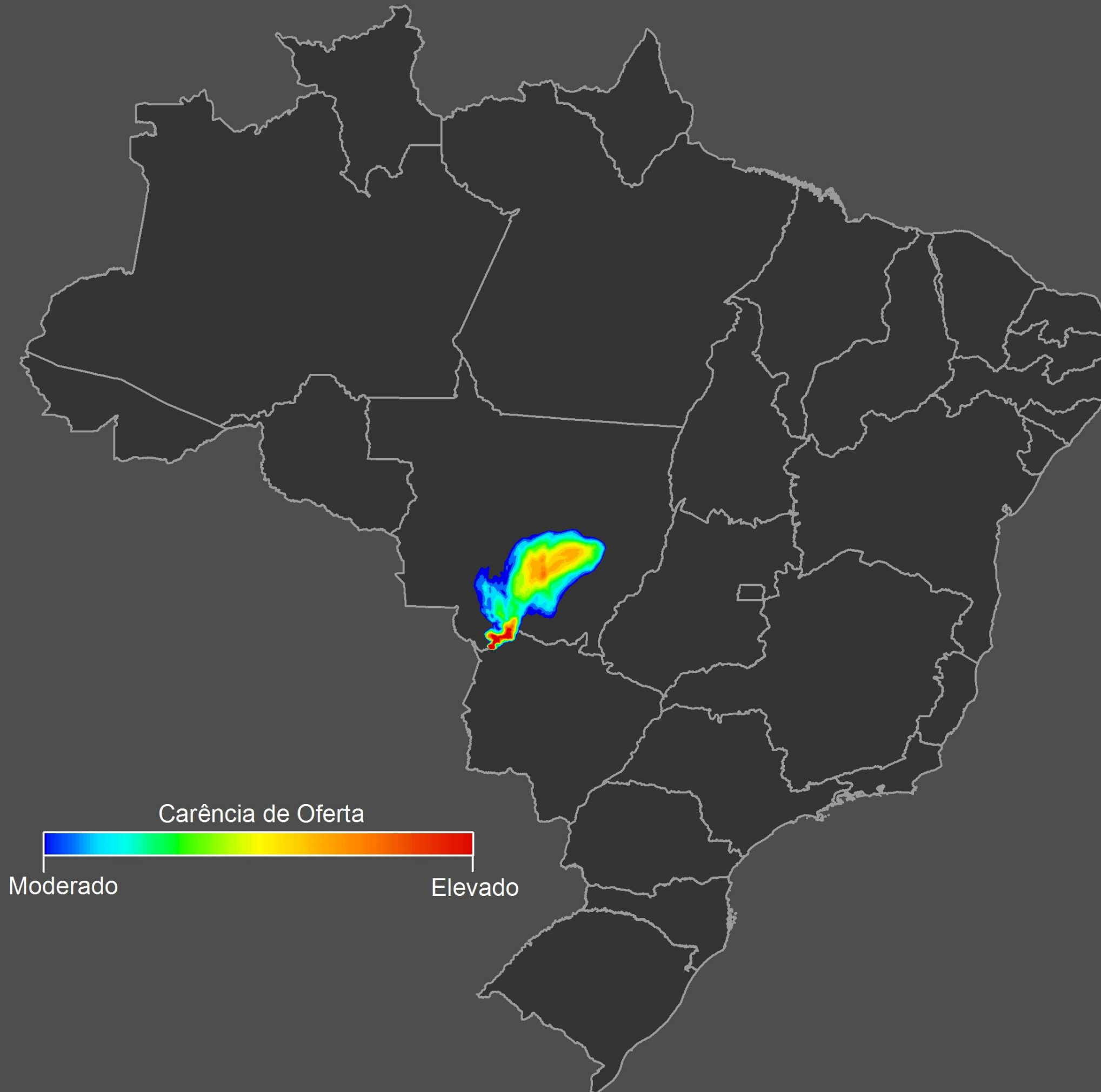
Obs: classes filtradas para o intervalo 0.8 – 1. A área correspondente ao valor 1 era muito pequena





# Carência de Oferta para Agrominerais Silicáticos

300 km  
Obs: classes filtradas para o intervalo 0.8 – 1. A área correspondente ao valor 1 era muito pequena

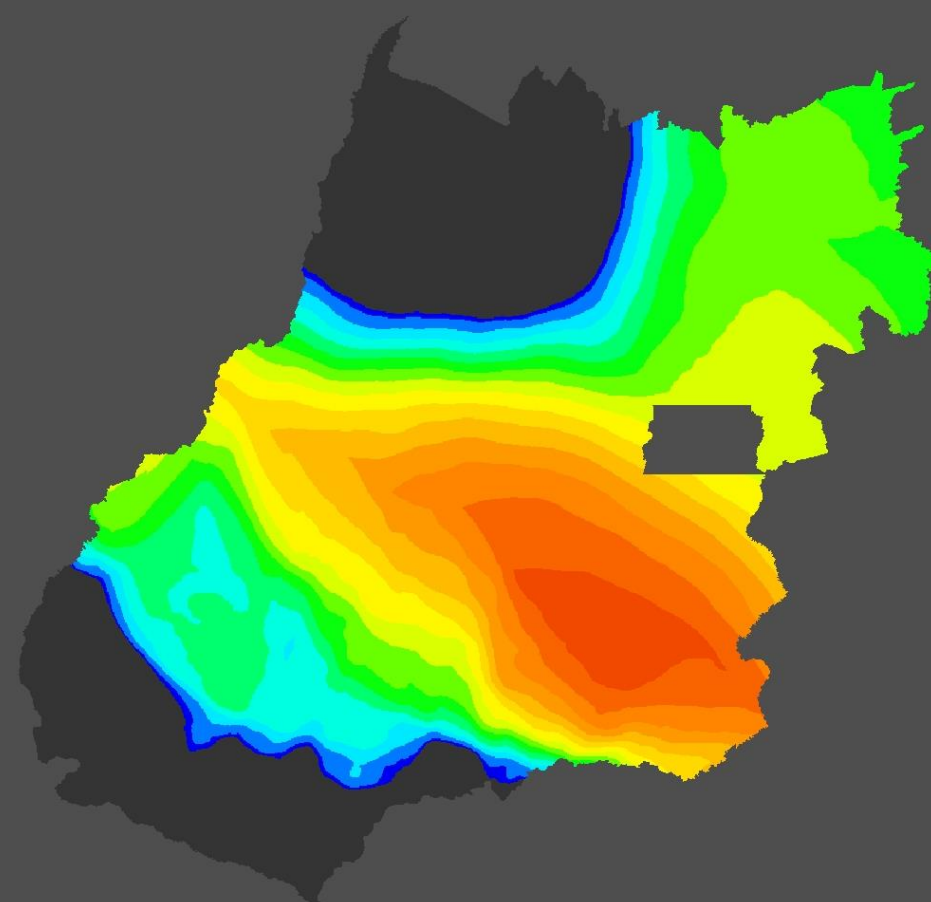




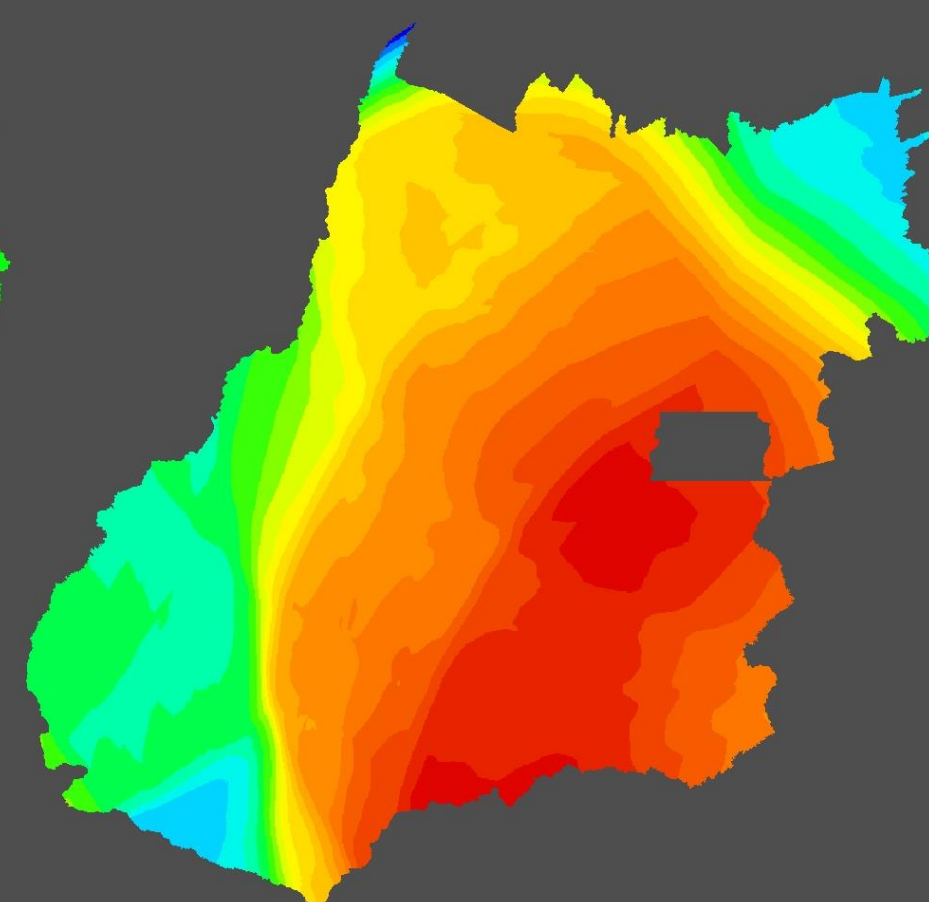
# Potencial Econômico para Agrominerais - GO



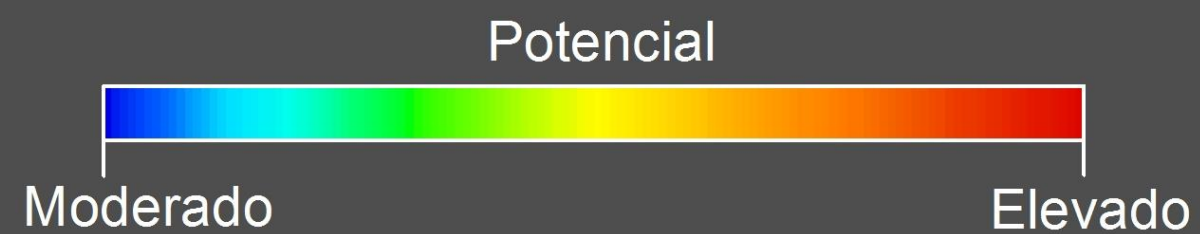
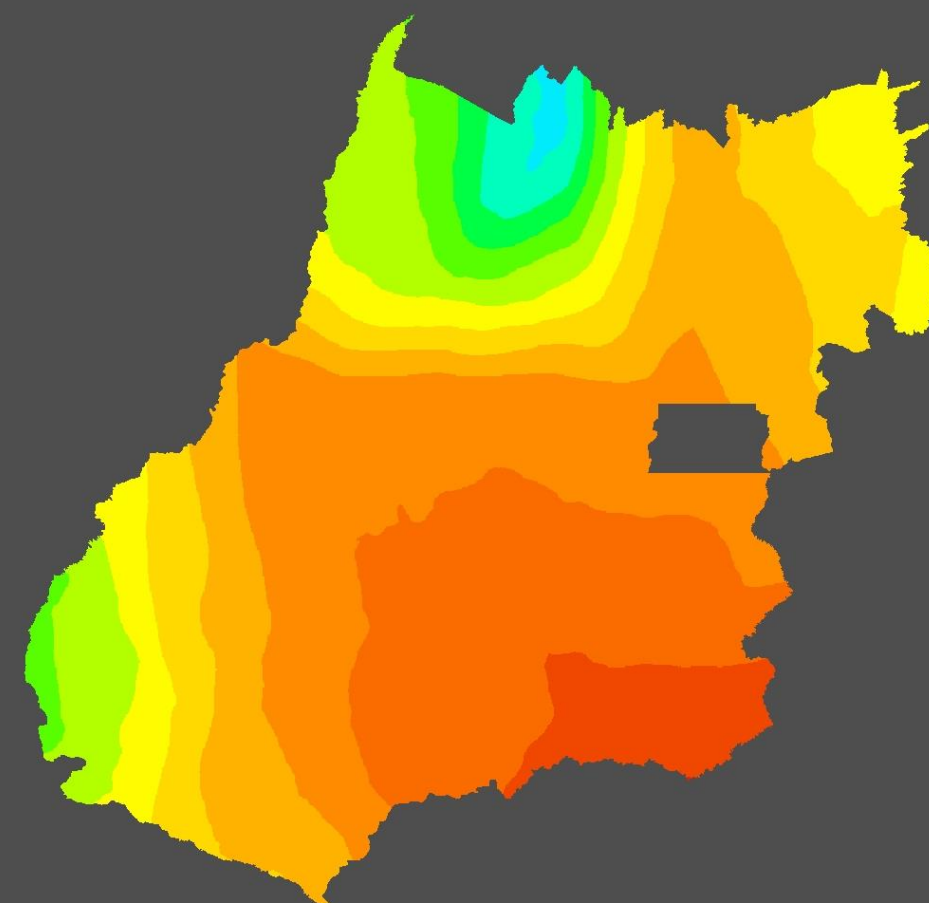
Carbonatos



Fosfato Sedimentar



Agrominerais Silicaticos

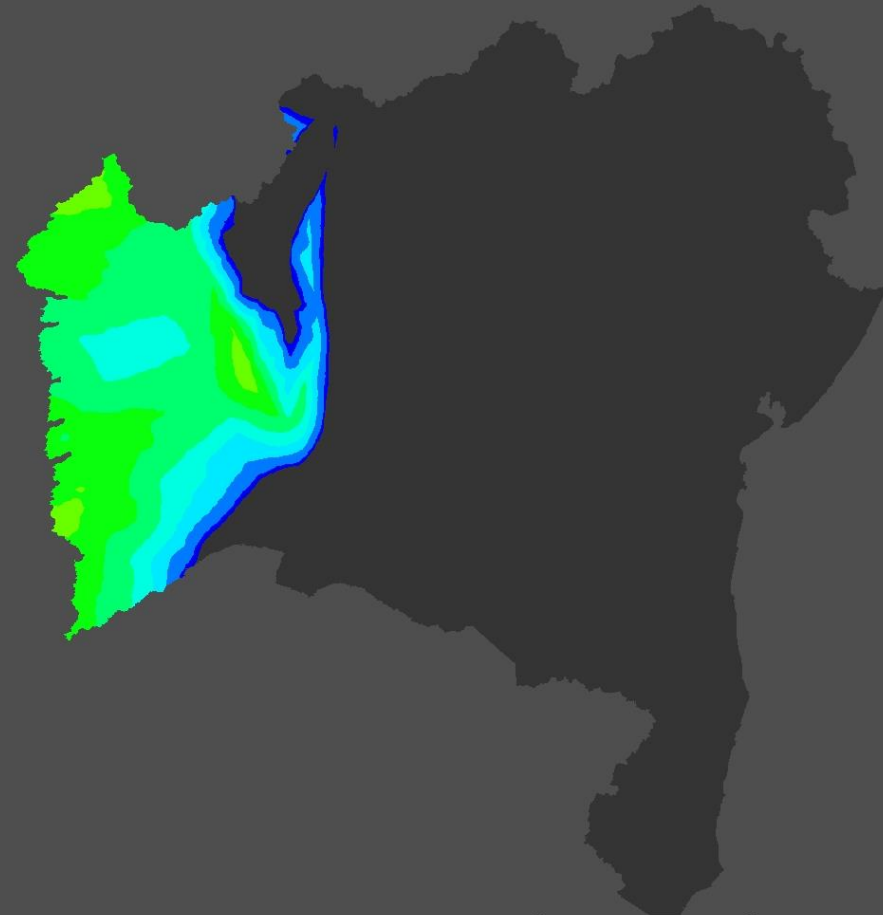




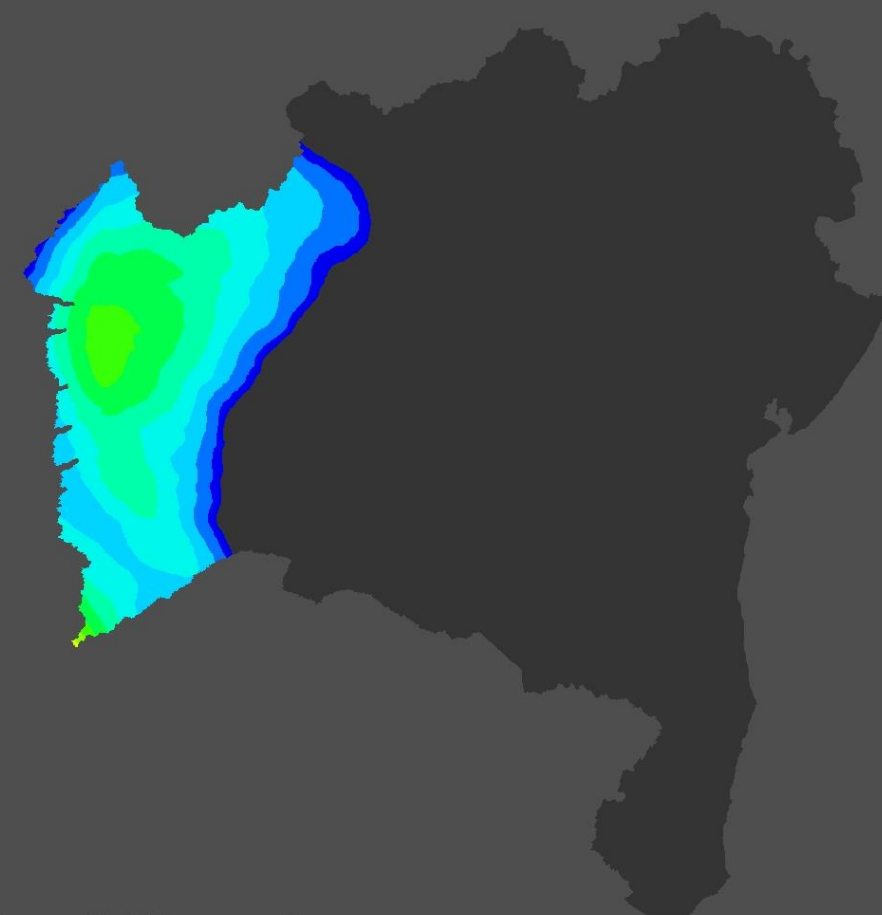
# Potencial Econômico para Agrominerais - BA



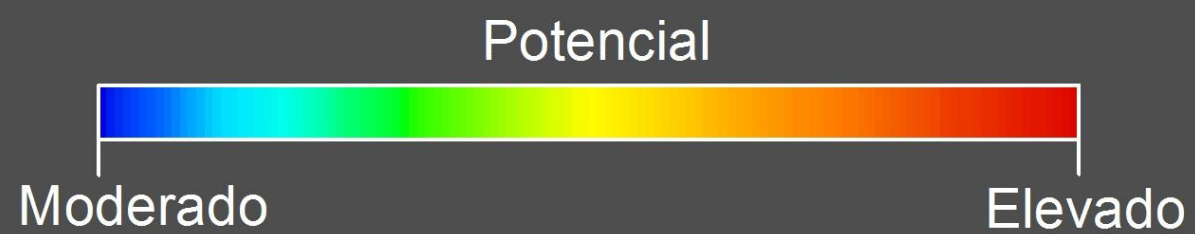
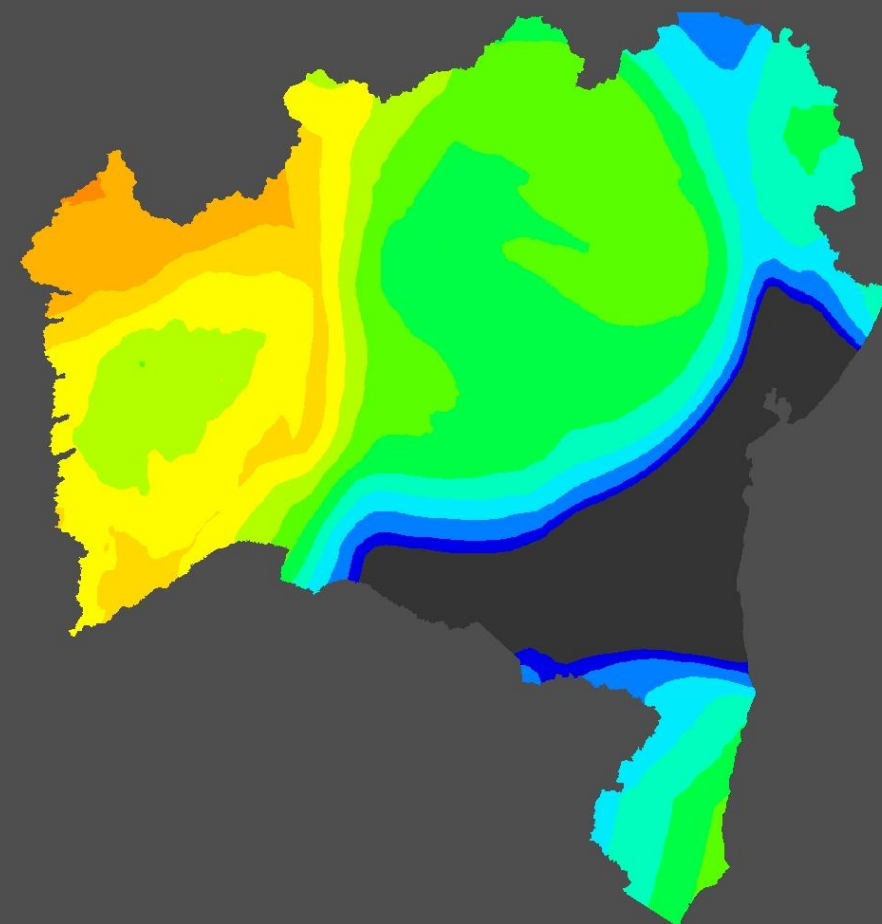
Carbonatos



Fosfato Sedimentar



Agrominerais Silicaticos

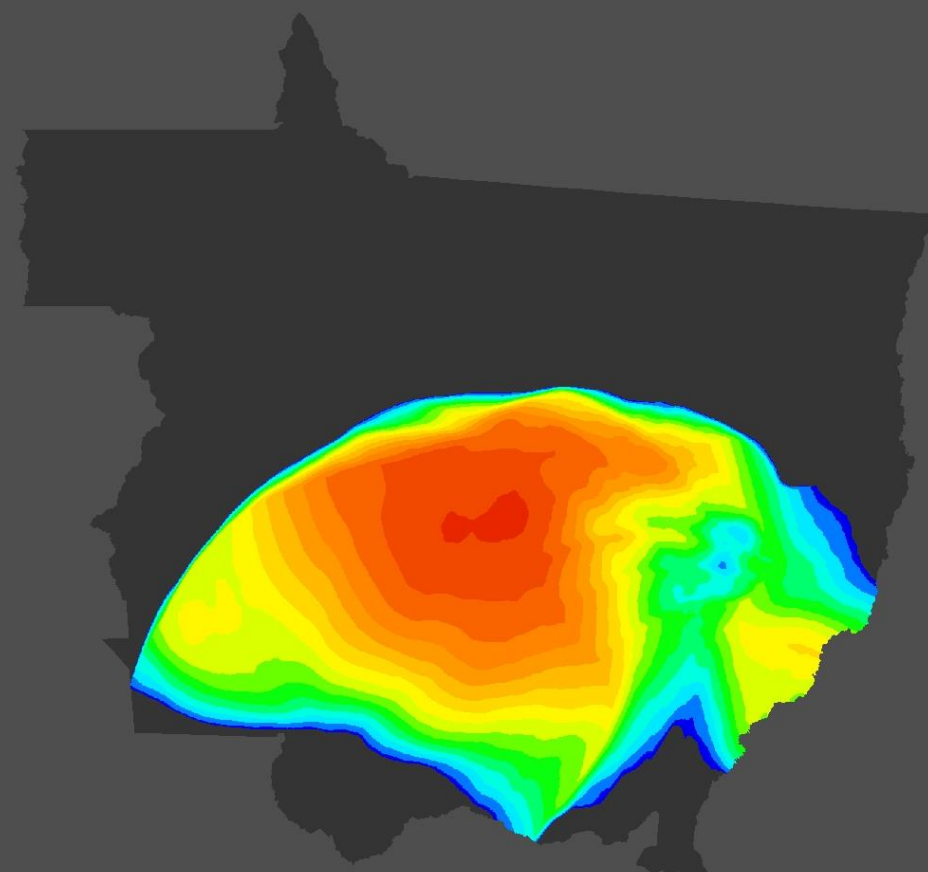




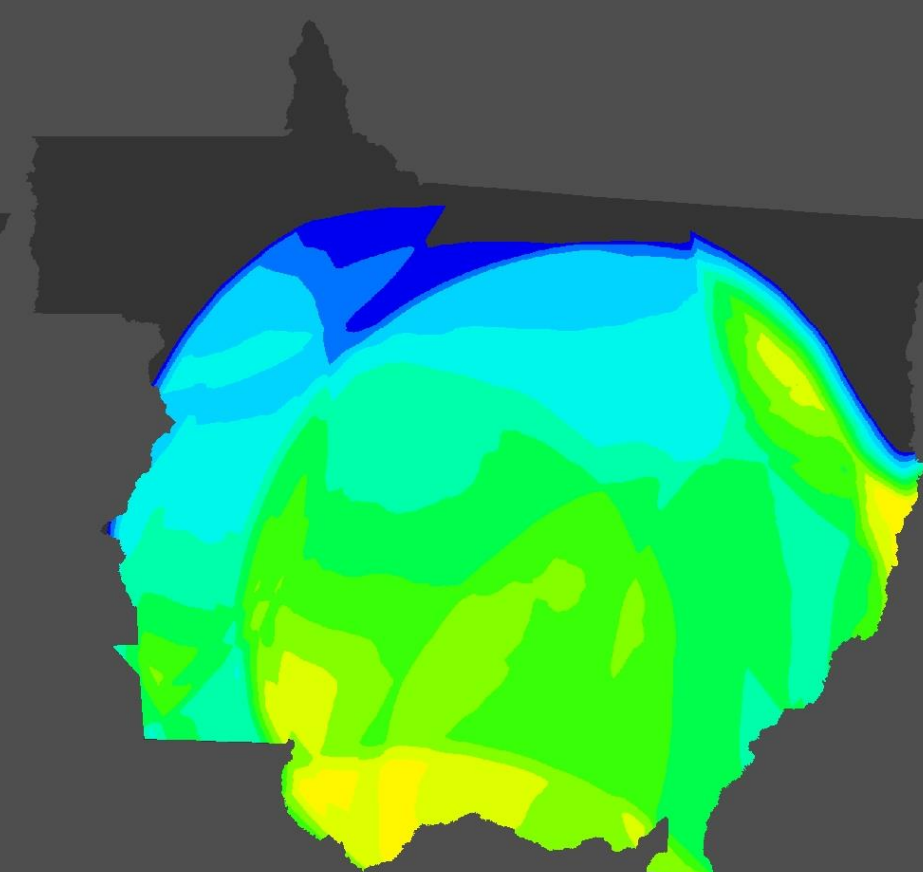
# Potencial Econômico para Agrominerais - MT



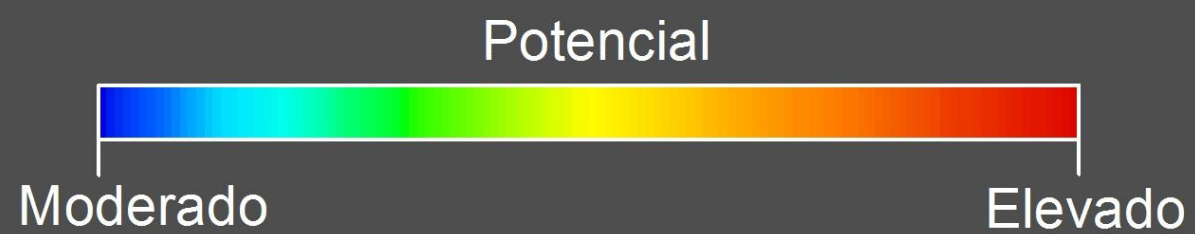
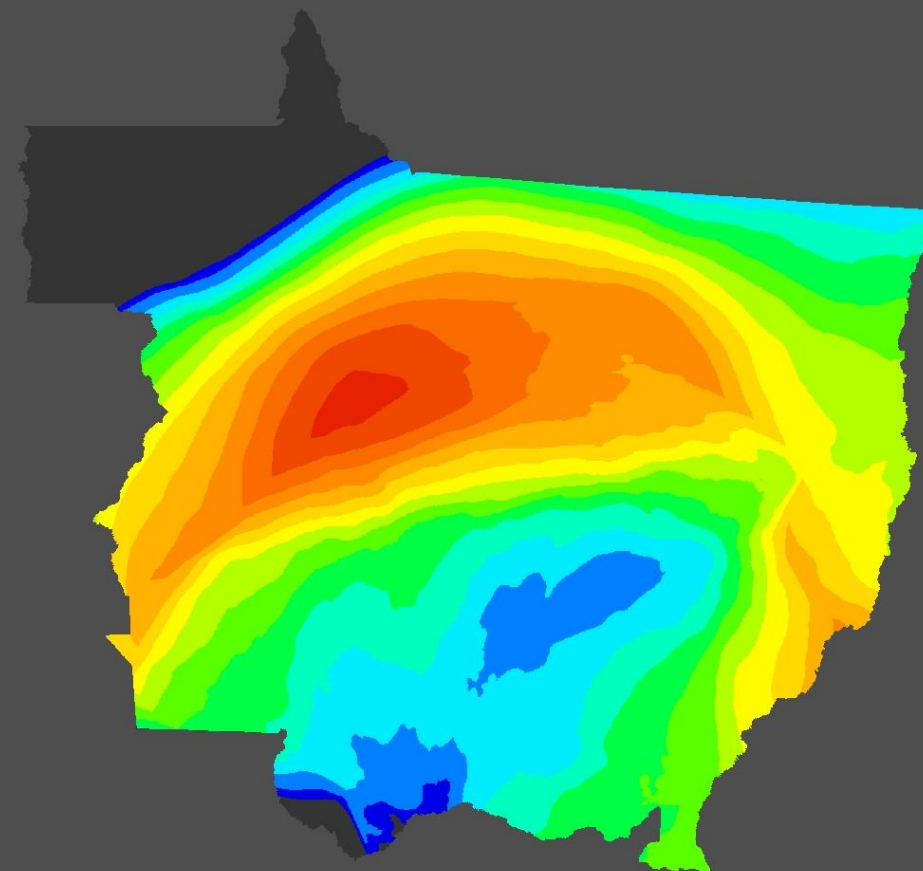
Carbonatos



Fosfato Sedimentar



Agrominerais Silicaticos

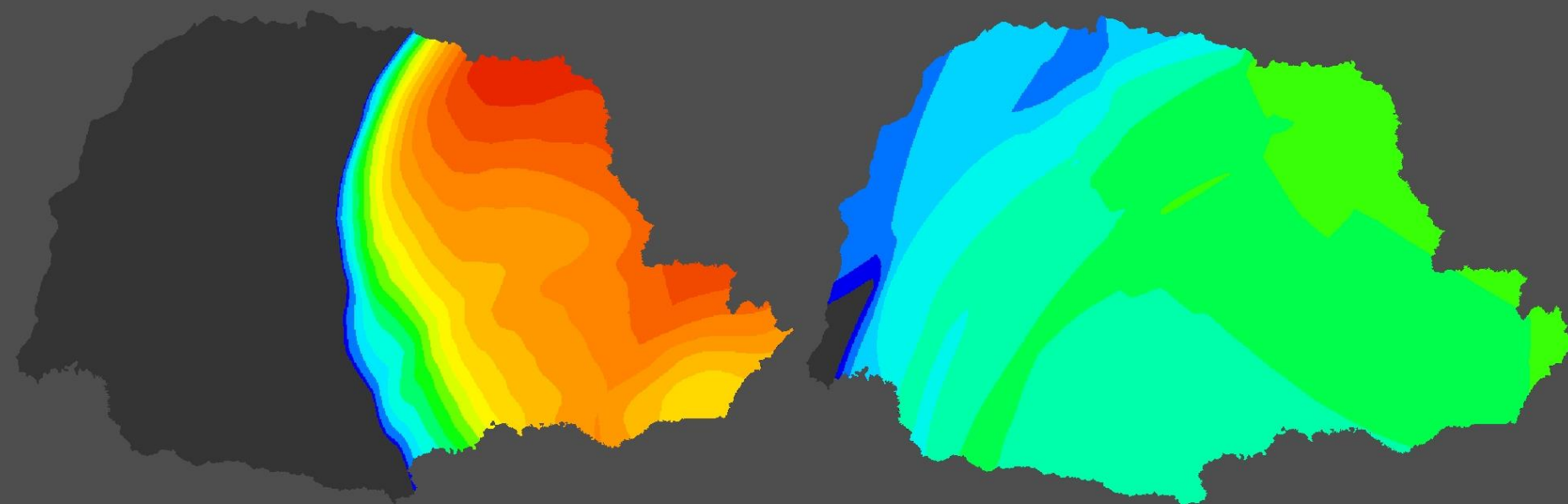




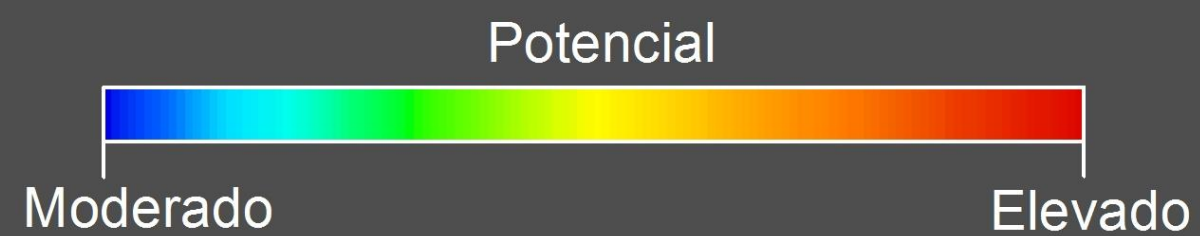
# Potencial Econômico para Agrominerais - PR

Carbonatos

Fosfato Sedimentar



Agrominerais Silicaticos

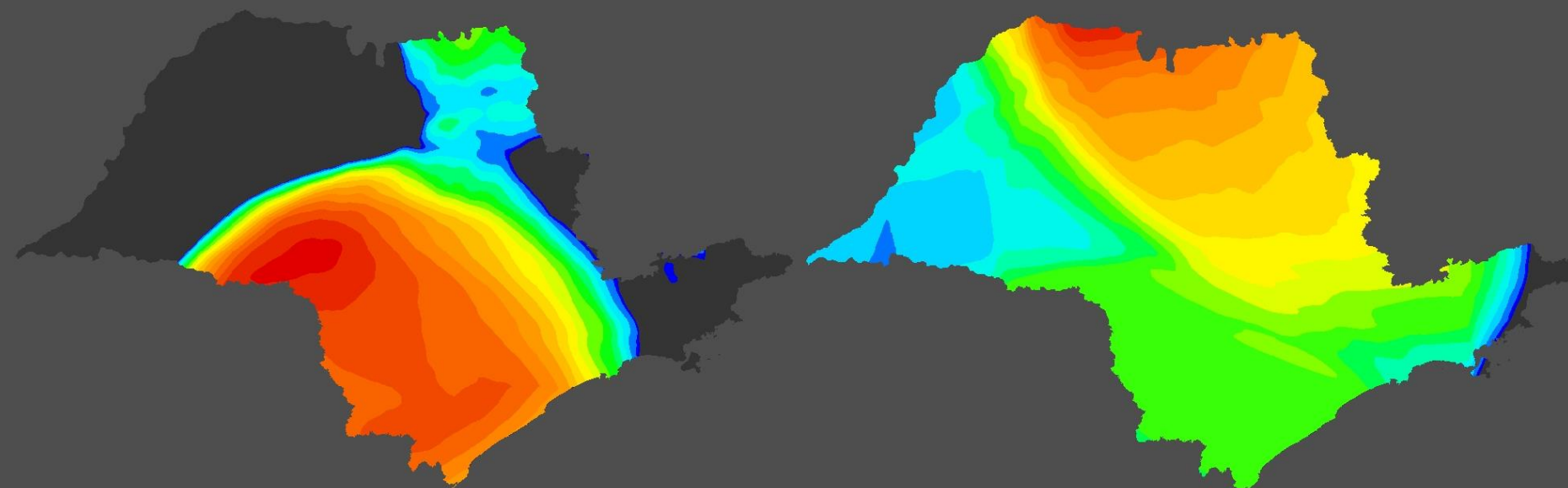




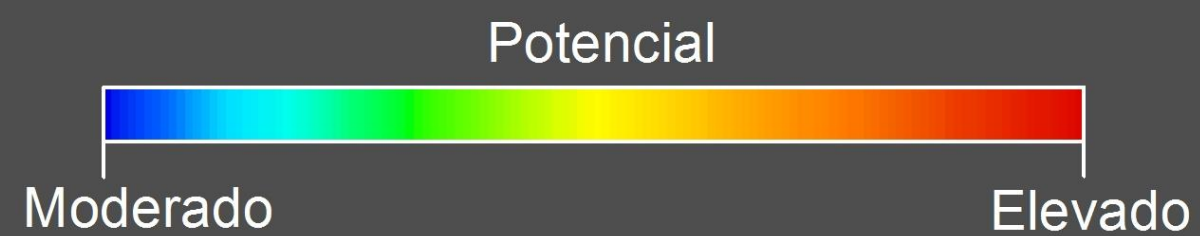
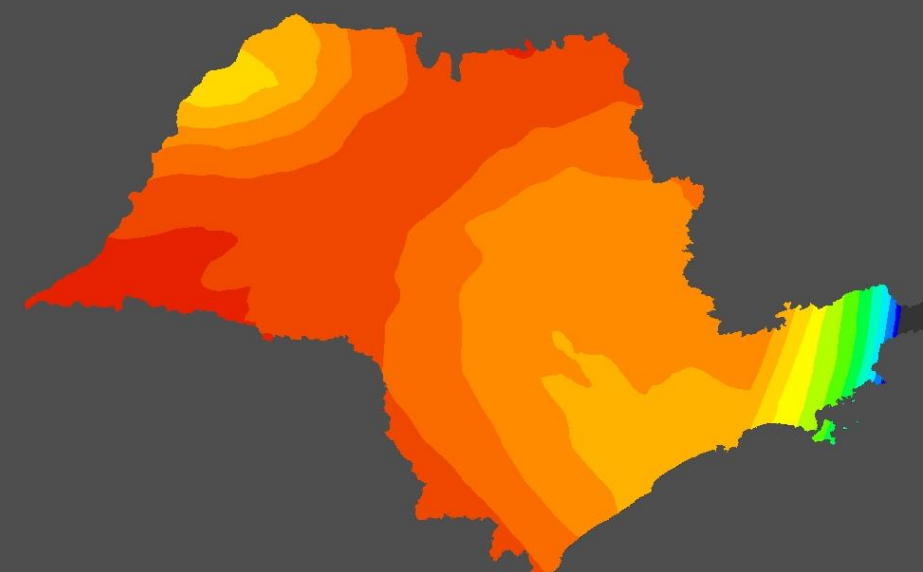
# Potencial Econômico para Agrominerais - SP

Carbonatos

Fosfato Sedimentar



Agrominerais Silicáticos

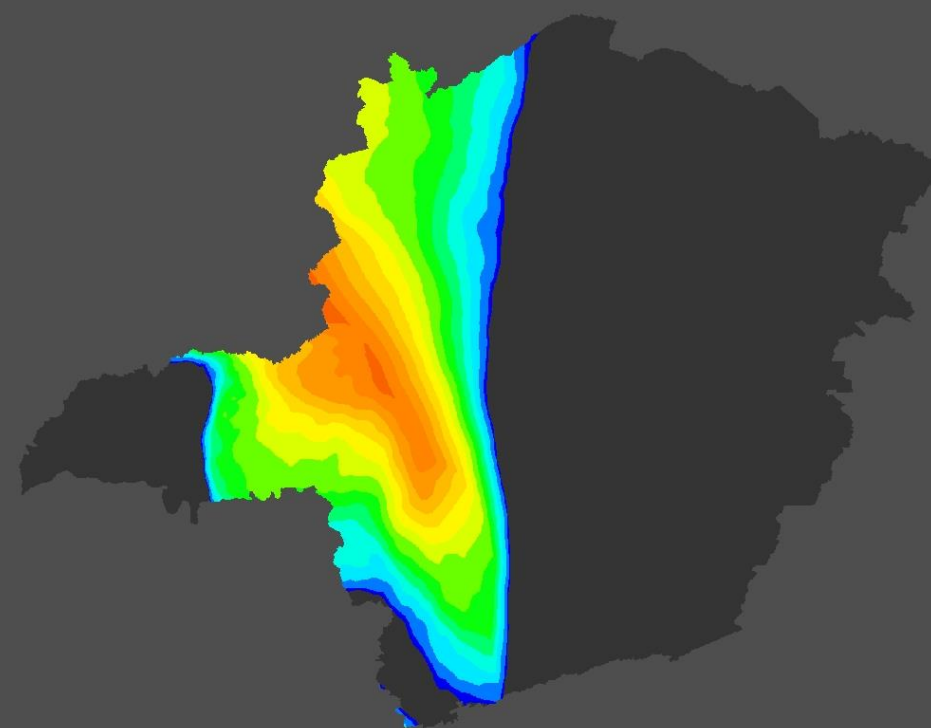




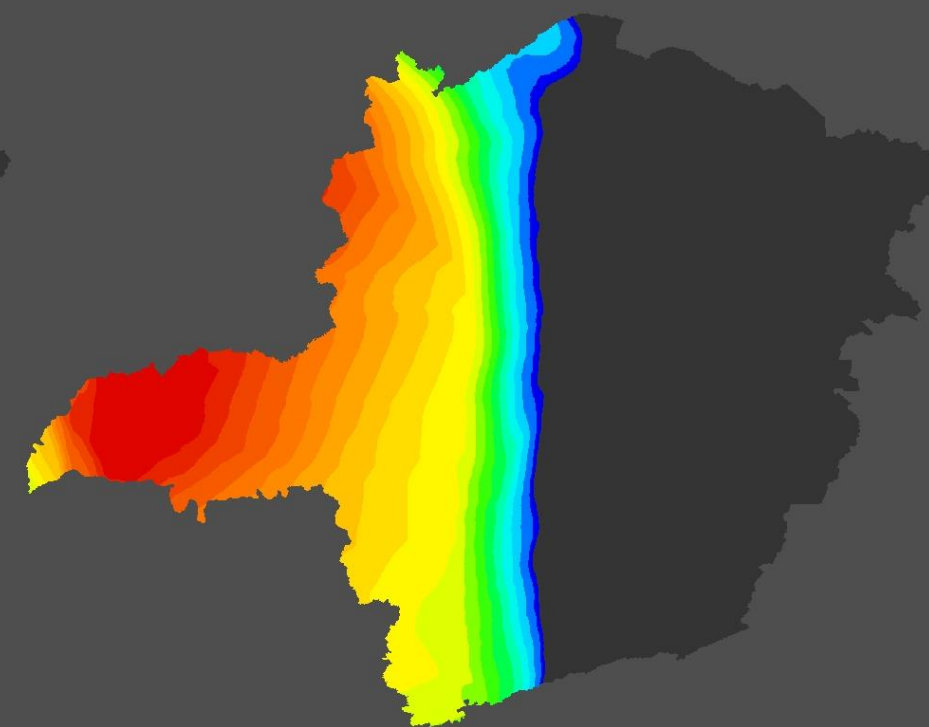
# Potencial Econômico para Agrominerais - MG



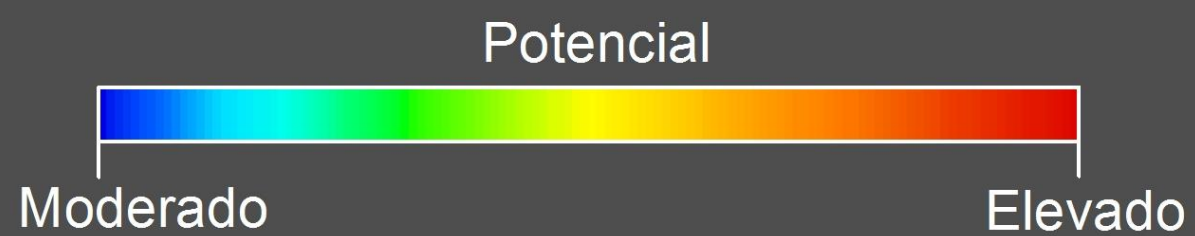
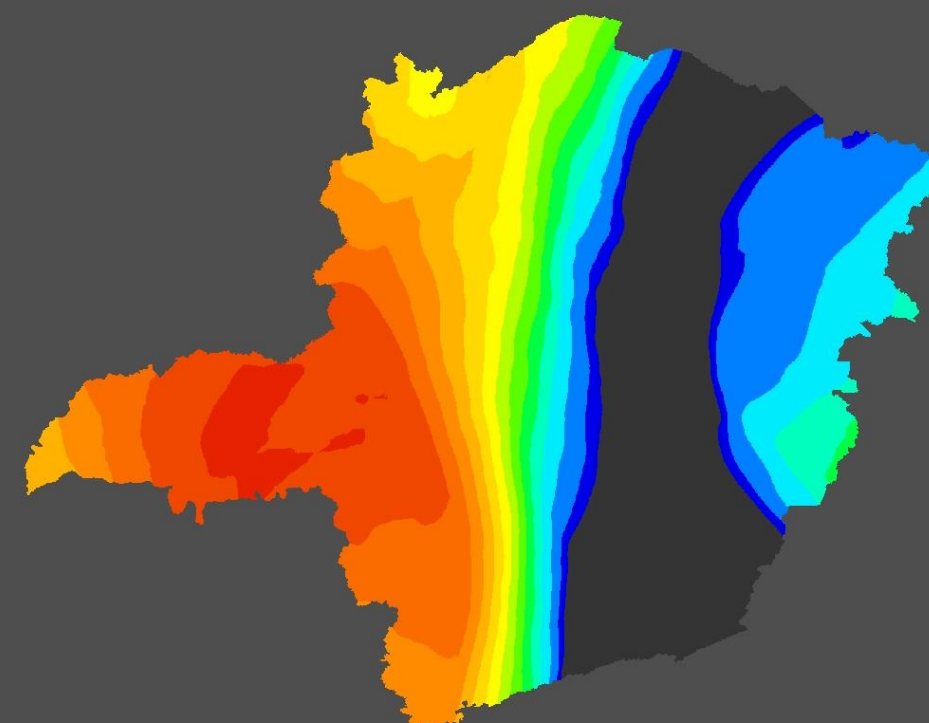
Carbonatos



Fosfato Sedimentar



Agrominerais Silicaticos





# Processo Agrogeológico

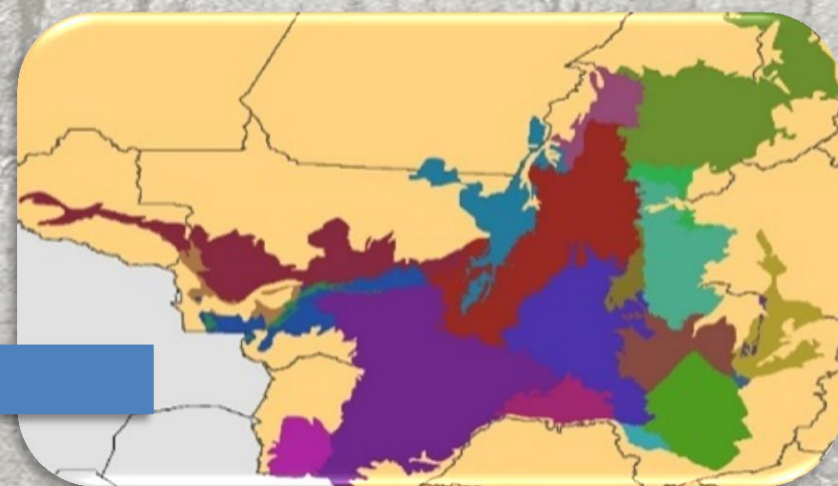
- 1. Agrogeologia:** Estudo dos solos agrícolas e das fontes de nutrientes, remineralizadores e condicionadores de solo regionais;
- 2. Seleção de agrominerais:** Função da disponibilidade, composição química, mineralógica, e eficiência agronômica;
- 3. Produção de agrominerais:** Definição da tecnologia de beneficiamento em função da eficiência agronômica;
- 4. Manejo:** Aplicação de agrominerais regionais com a finalidade de manejar a fertilidade do solo (nutrientes + cargas negativas).



3. Produção de agrominerais

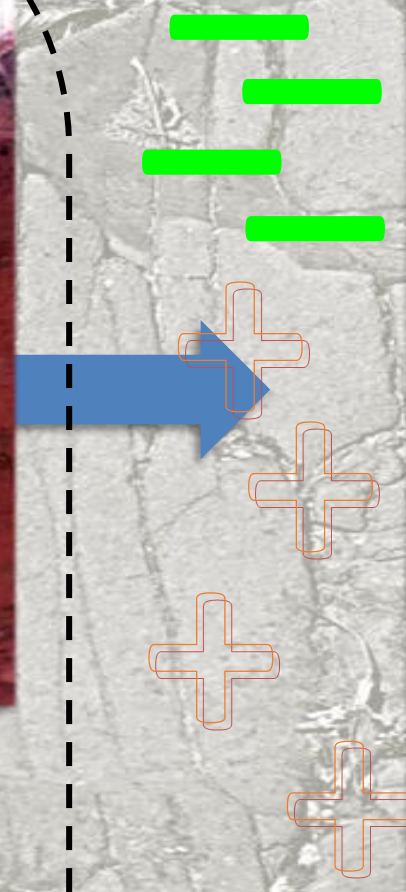
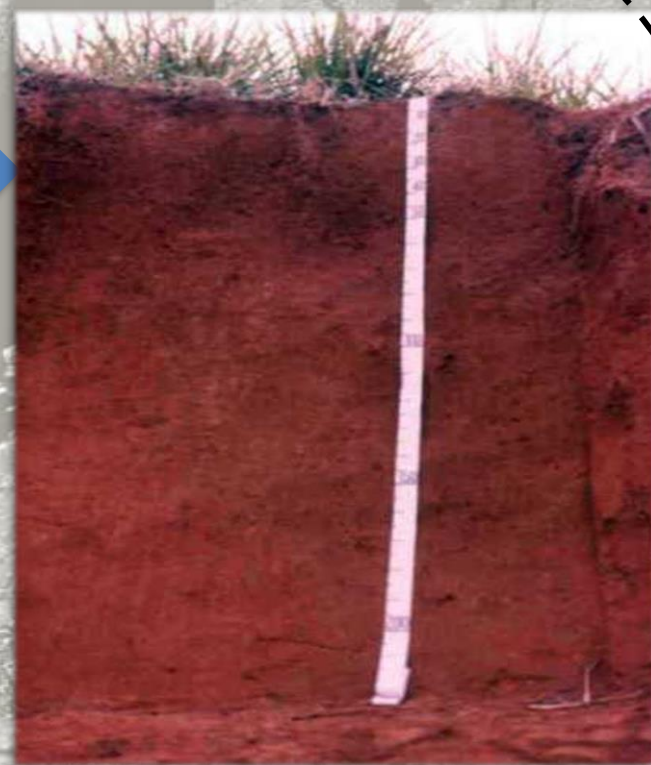


2. Seleção de agrominerais

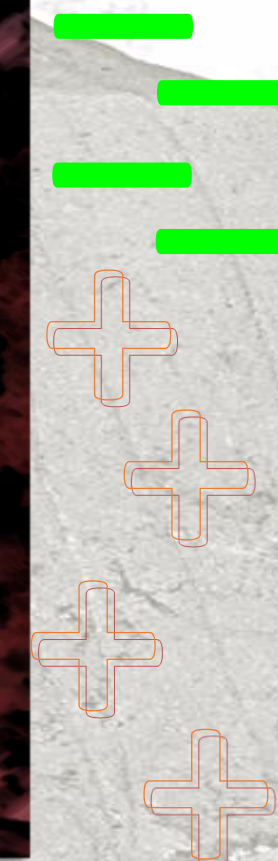
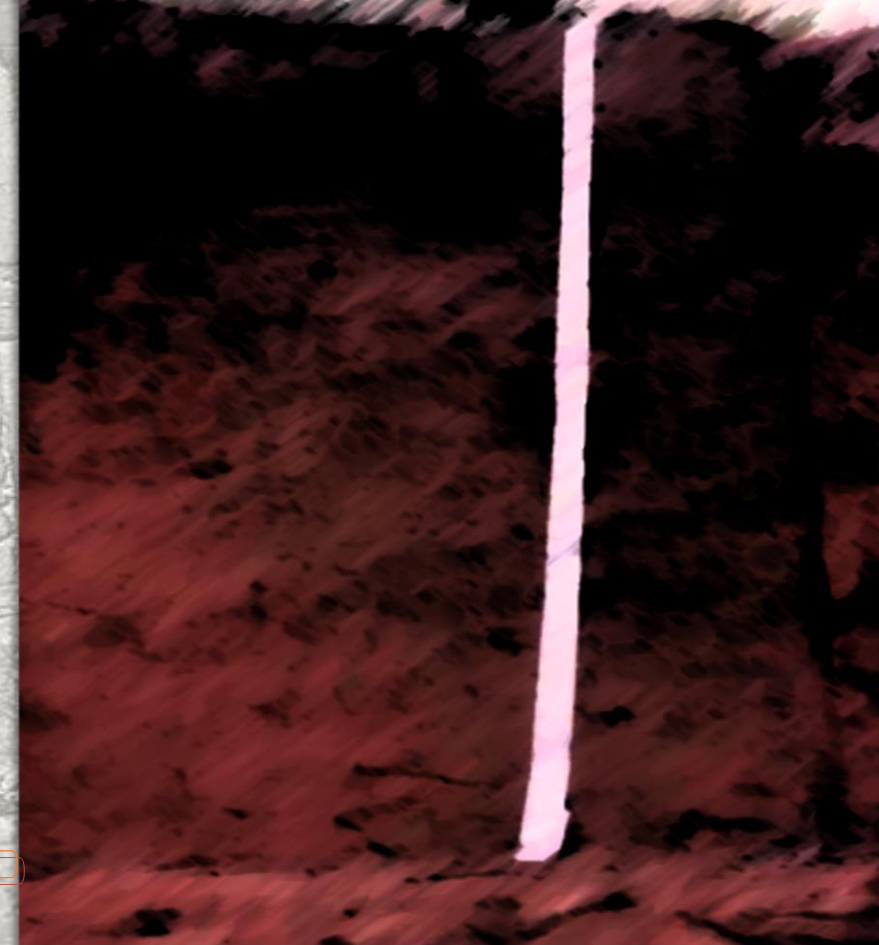


1. Agrogeologia

4. Manejo



# Produção de Solo



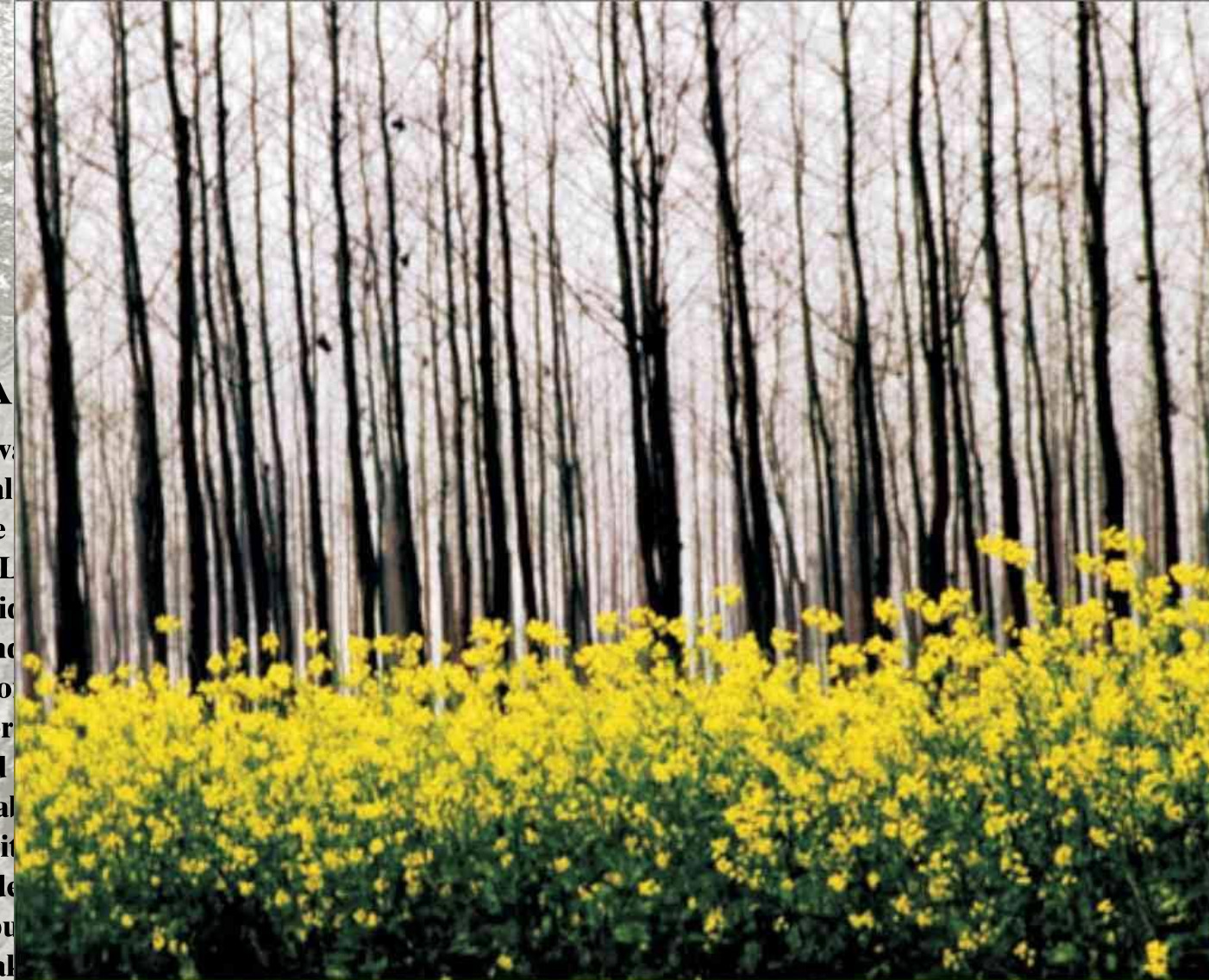
**Produção de solo:** Formação de nova camada de solo a partir do intemperismo da rocha moída no solo original ao longo do tempo.

- **Propriedades emergentes** – aumento da capacidade produtiva; intensificação ecológica; melhoria da eficiência de aproveitamento de nutrientes; mitigação do efeito estufa...



# Novo paradigma

The Green Revolution was a period of dramatic increase in agricultural production and technological innovation in agriculture. It was characterized by the development of high-yielding varieties of wheat and rice, the use of chemical fertilizers and pesticides, and the adoption of modern agricultural practices. The Green Revolution led to increased food security and economic growth in many developing countries, but it also had significant environmental and social impacts. Environmentalists emphasize the negative effects of pesticides, as well as the monoculture and the degradation of soil. Social scientists for its dependence on market-purchased inputs, which often excluded small farmers. In many developing countries, the Green Revolution led to an alignment of population growth with food production, but it also led to the marginalization of many small farmers.



## From Green to Evergreen Revolution

Indian Agriculture:  
Performance and Challenges

MS Swaminathan

...ience to shape our ag-  
... was coined by Dr. ...  
...tment of Agriculture ...  
...inary progress taking ...  
...f South Asia, in terms ...  
...netic material for the ...  
...ological rhythm came ...  
...Wheat Improvement ...  
...he case of wheat, and ...  
...nstitute (IRRI) in the ...  
...enes for the semidwarf ...  
...wheat from Japan and ...  
...China. Increased yield ...  
...e genotype and high- ...  
...reated by the applica- ...  
...gation water. In India, ...  
...m the program of Dr. ...  
...clear, even in the very ...  
...midwarf cultivars were ...  
...o in productivity when ...  
...ic practices.  
...ns were organized in ...  
...chnologies. The events ...  
...he wheat revolution of ...  
...in a publication titled, ...  
...(Swaminathan, 1993).



THE CHALLENGE NOW



***“DEIXEMOS QUE O AMBIENTE GUIE NOSSO  
DESENVOLVIMENTO”  
Johan Rockström***