HAIR MINERAL ANALYSIS

Hair Mineral Analysis.

SUBJECT

John Smith

Male Adult · Human — Head · DOB 1985-06-15

LAB NUMBER

HMA250012

Previous HMA240008

SAMPLE COLLECTED

2026 · 06 · 20

RECEIVED IN LAB

2026 · 06 · 23

REPORT RELEASED

2026 · 06 · 25

For practitioner use only. Not for direct distribution to the patient.

REQUISITIONING

Dr. John Doe

Practitioner ID · 200

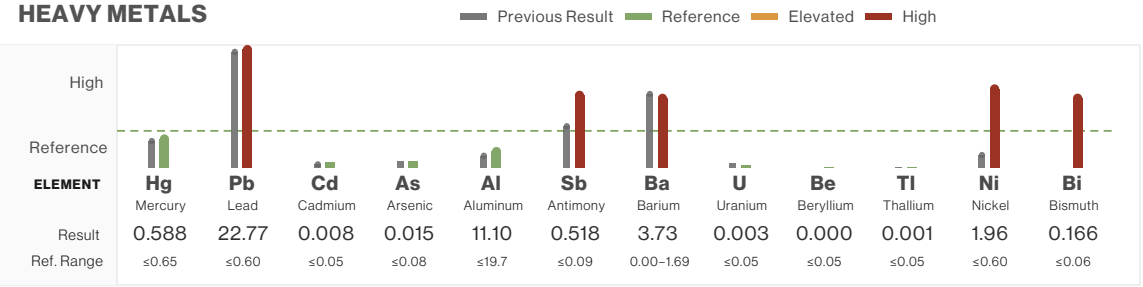
Hair Mineral Analysis | John Smith | Head hair | Male Adult

CanAlt Health Laboratories

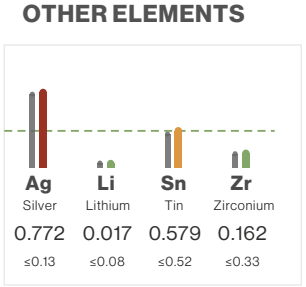
Sample ID **HMA250012** Prev Sample **HMA240008** Practitioner **Dr. John Doe (200)**

DOB **1985-06-15** Collected **2026-06-20** Received **2026-06-23** Report **2026-06-25**

HEAVY METALS



OTHER ELEMENTS



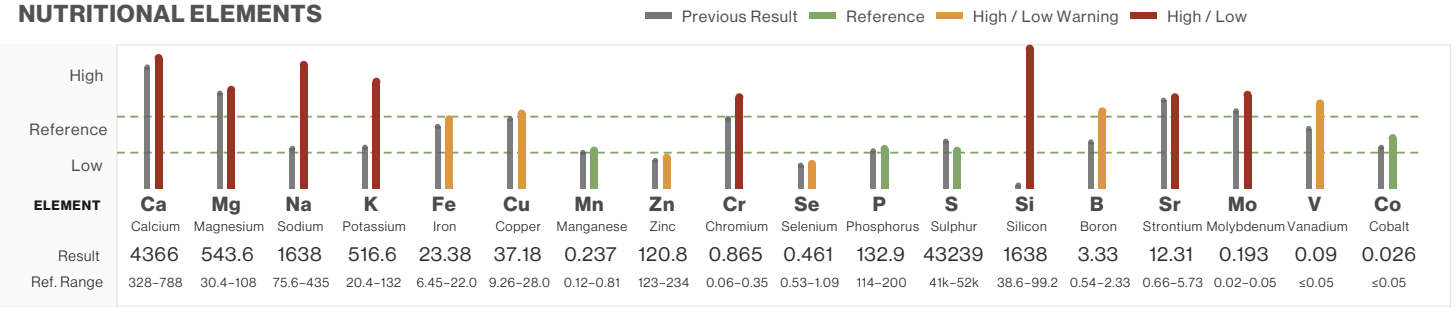
MINERAL-HEAVY METAL RATIOS

Protective mineral-to-toxic metal ratios reflect the body's capacity to buffer against heavy metal burden.

Ratio	Current	Previous	Range
Ca : Cd	545,750	—	>800
Fe : Pb	1.0 ▼	—	>20.0
Zn : Hg	205.4	—	>200
Se : Hg	0.78 ▼	—	>1.00

Ratio	Current	Previous	Range
Se : As	30.7	—	>10.0
Fe : Hg	39.8	—	>22.0
Ca : Pb	191.7	—	>84.0
Zn : Cd	15,100	—	>800

NUTRITIONAL ELEMENTS



ENERGY & METABOLISM RATIOS

Mineral patterns governing thyroid, adrenal, and cellular energy function.

Ratio	Current	Previous	Range
Ca : Mg	8.0	—	5.20–19.5
Ca : Na	2.7	—	0.43–5.10
Ca : K	8.5 ▲	—	0.59–5.57
Na : Mg	3.0	—	0.99–11.6
Na : K	3.2 ▲	—	0.86–2.71
K : Mg	0.95	—	0.33–5.18

STRUCTURAL RATIOS

Ratios tied to bone density, connective tissue, and iron–copper balance.

Ratio	Current	Previous	Range
Ca : P	32.9 ▲	—	1.60–3.99
Ca : Sr	354.7	—	154–670
Ca : Zn	36.1 ▲	—	1.62–7.54
Fe : Cu	0.63	—	0.26–1.20
Zn : Cu	3.2 ▼	—	4.92–25.6
Ca : Fe	186.7 ▲	—	17.1–82.7

ADDITIONAL RATIOS

These ratios are provided for additional information only.

Ratio	Current	Previous
Mg : P	4.1	—
Fe : Mn	98.6	—
Cu : Mo	192.6	—
Cu : Se	80.7	—

Ratio	Current	Previous
S : Cu	1,163	—
Zn : Fe	5.2	—
Zn : P	0.91	—
Zn : Se	262.0	—

Disclaimer: Results for Ca, Mg, Na, K, and Li as well as related ratios and patterns are provided for research and informational purposes only — see full disclaimer.

Sample ID **HMA250012** Prev Sample **HMA240008** Practitioner **Dr. John Doe (200)**

DOB **1985-06-15** Collected **2026-06-20** Received **2026-06-23** Report **2026-06-25**

OXIDIZER TYPE: Moderate Slow

Cut-offs: Ca/K 8–16 | Na/Mg 1–2

This indicates a clearer shift toward slowing. The report highlights stronger elevations in Ca/Mg (often biounavailable forms) and lower Na/K, pointing to noticeable adrenal fatigue and reduced detox capacity. Copper and other hidden toxicities are frequently more entrenched. The body experiences more pronounced parasympathetic dominance with glandular underactivity. A nutritional and lifestyle approach that focuses on consistent rest, gentle remineralization, and supportive practices to enhance glandular and digestive function is typically most beneficial.

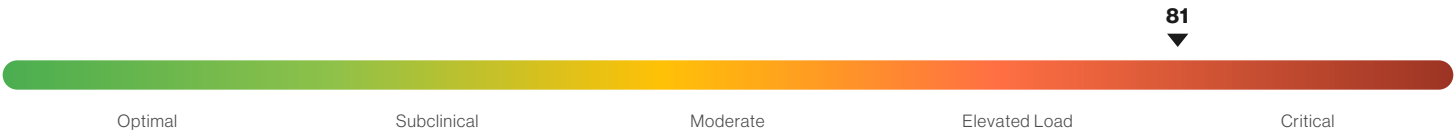
Notable Observations

- Chronic fatigue, low mood, or apathy commonly observed.
- Weight gain (especially hips and legs), dry skin or hair, and constipation are typical.
- Brain fog, slower thinking, and poor resilience to stress are frequent.
- Low blood pressure or blood sugar and underactive glandular function present.
- Parasympathetic dominance is pronounced.

MACROMINERAL PATTERNS

	STATUS	CRITERIA
Calcium Shell	IDENTIFIED	Ca > 2000 µg/g
Magnesium Shell	—	Mg > 200 µg/g and Mg > 0.15 × Ca
Extreme Na/K	—	Na/K < 1.0 or Na/K > 10.0
Sympathetic Dominance	—	Ca/K < 4.0 and Ca/Mg < 6.0
Parasympathetic Dominance	—	Ca/Mg > 9.5 and Ca/K > 10.0
Four-Low	—	Ca < 400, Mg < 60, Na < 250, K < 100 µg/g
Four-High	IDENTIFIED	Ca > 875, Mg > 100, Na > 370, K > 115 µg/g
Reduced Buffering Capacity	IDENTIFIED	Ca > 875, Mg > 100, Sr > 6.0, Ba > 3.0 µg/g
Bio-unavailable Ca and Mg	IDENTIFIED	Ca > 2000 µg/g, Mg > 100 µg/g

ELEMENTAL BURDEN INDEX: Critical



The Elemental Burden Index summarizes overall load from essential and toxic elements; it is covered in detail separately. The Advanced HMA Report provides a comprehensive breakdown spanning Stress, Nutrition, Lifestyle factors, Cellular Metabolism, and Hormone activity, all derived from the patient's hair mineral and toxic metal profile.

Disclaimer: Any information regarding Ca, Mg, Na, K and Li is for research and informational purposes only.

HMA Methodology.

Interpretive guidance draws on the **licensed elements** — their measured values, their relationships to one another, and the peer-reviewed literature describing their patterns of utilization, deposition, exposure, and excretion. The research-only macrominerals are presented as parallel reference data, not as the interpretive framework.

01 · ESTABLISH
Pattern
Macromineral framework: Ca·Mg for direction, Na·K for stress response.

02 · CLARIFY
Ratios
Balance, compensation, antagonism — relationships rather than absolutes.

03 · OBSERVE
Trend
Months-long view across repeats — coherence and directional change.

04 · APPLY
Sequence
Prioritize, sequence, and pace foundational regulation work.

INTERPRETIVE APPROACH

The licensed analytical scope of this report comprises the trace nutritional minerals and the toxic and non-essential elements tested under CanAlt Health Laboratories' Ontario laboratory licence. Interpretive guidance draws on those licensed elements: their measured values, their relationships to one another, and the literature describing their patterns of utilization, deposition, exposure, and excretion.

Trace nutritional minerals are evaluated as indicators of nutritional status, longer-term demand, and utilization, with attention to relationships among elements rather than to single values in isolation. Toxic and non-essential elements are evaluated as indicators of exposure and elimination patterns; they are not measures of total body burden and are not diagnostic of poisoning or any specific toxicological condition. Where multiple analyses over time are available, interpretation focuses on patterns and trends across repeats rather than on values at single time points.

The macrominerals — calcium, lithium, magnesium, potassium, and sodium — fall outside the laboratory's licence and are reported for research and education only. They are presented as parallel reference data the practitioner may consult at their own discretion and professional responsibility. The laboratory does not rely on them as the framework for interpretation of the licensed elements.

LIMITS OF HAIR MINERAL ANALYSIS

Hair mineral analysis is a longitudinal and statistical method. Its results are subject to influences including hair treatments, environmental exposures, individual physiology, washing and preparation protocols, and analytical variability inherent to the methodology. It is well suited for identifying patterns and trends across repeat analyses and is not a substitute for clinical history, physical assessment, or confirmatory blood, urine, or imaging testing where clinically indicated.

INTERPRETIVE LIMITS & THE PRACTITIONER'S ROLE

This report does not diagnose, and does not imply a diagnosis of, any disease, disorder, or condition. The relationships and patterns described are characterizations of mineral relationships observed in the analyzed specimen; they are not characterizations of the patient's state of health. The patient's clinical state must be assessed by the practitioner using their own clinical methods, of which this report is one possible adjunct input. Summaries of peer-reviewed clinical associations inform research and education and are not endorsements of any diagnostic or therapeutic course.

USE OF TRENDS & REPEAT ANALYSES

Where repeat analyses are available, the interpretive narrative draws preferentially on directional shifts and pattern stability across analyses rather than on absolute values from any single specimen. The laboratory considers patterns over months to be more informative than point-in-time deviations, given the longitudinal character of hair mineral incorporation.

Disclaimer.

The following terms apply to all information contained in this hair mineral analysis report. **By using this report, the requisitioning practitioner acknowledges and accepts these terms.**

PRACTITIONER-ONLY DISTRIBUTION

This report is intended solely for distribution to the requisitioning practitioner, who must be a regulated health professional whose scope of practice authorizes the ordering and interpretation of laboratory tests for the patient identified here. It is not intended for direct distribution to the patient. The practitioner agrees not to share the raw report with the patient without their own independent contextualization and clinical interpretation.

THIS REPORT IS NOT DIAGNOSTIC

The analytical results and literature summaries do not constitute a medical diagnosis and should not be interpreted as such. Results may be influenced by environmental exposures, hair treatments, individual physiological variation, and methodological variables inherent to the technique. Interpret any results alongside a comprehensive medical history, physical assessment, and confirmatory or supplementary testing as clinically appropriate. This report does not recommend or imply any diagnosis or course of treatment.

RESEARCH-ELEMENT VALUES ARE STATISTICAL POSITIONS

Where this report presents a reference range or percentile for a research element, that range reflects a statistical position within a reference population. As with distributions for traits such as adult height, values outside the reference range are commonly observed among symptom-free individuals and otherwise healthy populations. A value outside a reference range does not, in itself, indicate that anything is clinically amiss in the individual whose specimen was analyzed.

Where this report references literature describing associations between hair mineral values and conditions or physiological variables, those associations are reported as population-level epidemiological observations in study-attributed language. They are not predictive claims about the patient identified here. Many individuals in published cohorts exhibiting the cited associations were otherwise symptom-free.

Any reliance upon results for research elements — or upon ratios, percentile positions, patterns, or literature summaries derived from them — for clinical decision-making is at the practitioner's sole discretion and professional responsibility.

ELEMENTS WITHIN SCOPE OF LICENCE

Boron, chromium, copper, iron, manganese, molybdenum, selenium, zinc, lead, arsenic, cadmium, mercury, aluminum, antimony, barium, beryllium, bismuth, nickel, platinum, strontium, thallium, tin, titanium, tungsten, uranium, vanadium, and zirconium are tested under CanAlt's licence pursuant to the Laboratory and Specimen Collection Centre Licensing Act. Their results, narrative, and references may be used as inputs to the practitioner's independent clinical assessment, consistent with their regulated scope of practice.

ELEMENTS FOR RESEARCH & EDUCATION ONLY

Calcium, lithium, magnesium, potassium, and sodium — together with any ratios, indices, percentile positions, patterns, or composite values derived from them, and any literature summaries — are provided solely for research, educational, and informational purposes. They are not provided for any medical diagnosis, health assessment, prevention, or treatment, and the laboratory makes no representation that they are suitable for any such purpose.

SCIENTIFIC LITERATURE REFERENCES

Where this report includes references to or summaries of peer-reviewed publications, they are provided for the practitioner's convenience in remaining informed of current research, in study-attributed language ("has been associated with", "has been reported in some studies to"). They are not endorsements by the laboratory of any finding, methodology, or clinical recommendation. The practitioner is encouraged to consult the original publications and exercise independent judgment.

LIMITS OF HAIR MINERAL ANALYSIS

Hair mineral analysis is a longitudinal, statistical method whose results are subject to environmental exposures, hair treatments, individual physiology, washing and preparation protocols, and analytical variability. It is well suited for identifying patterns and trends across repeat analyses, and is not a substitute for clinical history, physical assessment, or confirmatory blood, urine, or imaging testing where clinically indicated.

PROFESSIONAL RESPONSIBILITY

Nothing in this report is intended to replace or diminish the professional obligations of the practitioner under applicable laws, regulations, and standards of practice. The practitioner retains full responsibility for any clinical decisions made in connection with the information presented in this report.

ISSUING LABORATORY

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JOHN SMITH

CALCIUM (Ca) HIGH · OUT OF RANGE

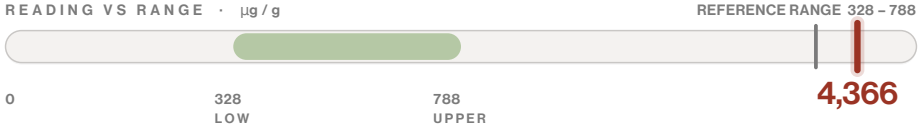
The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

20 40.078
Ca
Calcium
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 328 – 788



Reference range · Current 4,366 µg/g · *Previous 3,920 µg/g*

SCAN FOR REFERENCED LITERATURE

Calcium is the body's most abundant mineral and its dominant structural and buffering element.

The mineral-balancing literature has described calcium as a slow-acting sedative mineral; an elevated hair reading has been reported to reflect long-term metabolic pacing rather than recent intake. The literature has described an elevated reading as a marker of parasympathetic dominance and slow oxidation, with calcium observed to accumulate in tissue as a buffer against sustained stress, often at the cost of cellular activation and energy availability. Hair calcium is read alongside its relationships with magnesium, sodium, potassium, and phosphorus rather than the absolute value.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Nervous system & oxidation rate	An elevated calcium reading has been read in hair-analysis practice as a sedative, slow-oxidation marker, with calcium rising alongside magnesium as the body shifts toward parasympathetic dominance and a reduced metabolic tempo. It is interpreted against the Ca:K "thyroid ratio" and the oxidation-rate markers rather than as nutritional sufficiency. ***Watts DL, Trace Elements Inc. — HTMA calcium sedative / slow-oxidation convention***	Parasympathetic Dominance · Oxidizer Type: Slow/Extreme Slow · Ca 4,366 (▲) · Mg 544 (▲) · Ca:K 8.45 (▲) · Ca:Mg 8.03 (·)
Bone & skeletal metabolism	An elevated reading has been associated with calcium shifting out of bone into soft tissue rather than true skeletal sufficiency; research has shown that without adequate vitamin K and D, calcium is poorly directed into bone. It is read alongside the storage minerals and the Ca:P ratio. ***PMID 39125301***	Ca 4,366 (▲) · P 133 (·) · Ca:P 32.9 (▲) · Sr 12.3 (▲) · Ba 3.73 (▲) · Mg 544 (▲)
Cardiovascular & soft-tissue calcification	A widened Ca:Mg has been linked with vascular and soft-tissue calcification, with magnesium acting as a calcification inhibitor; an elevated calcium reading is read in that context rather than in isolation. ***PMID 29793668***	Ca 4,366 (▲) · Mg 544 (▲) · Ca:Mg 8.03 (·) · P 133 (·) · Ca:P 32.9 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Magnesium: balances calcium at the cellular level and at parathyroid hormone signalling. PMID 1939521 · Fatemi et al. 1991

Vitamin K2: activates osteocalcin and matrix Gla protein, directing calcium into bone rather than soft tissue. PMID 39125301 · Aaseth et al. 2024

Vitamin D: regulates intestinal calcium absorption via TRPV5/TRPV6 epithelial channels. PMID 12748856 · Nijenhuis et al. 2003

Dietary protein: supplies the collagen matrix into which hydroxyapatite crystallizes. ***PMID 11916747*** · *Heaney 2002*

ANTAGONISTS

Vitamin D supplementation without vitamin K2 drives calcium into circulation and soft tissue. ***PMID 17145139*** · *Masterjohn 2007*

Chronic stress elevates glucocorticoid output and shifts calcium from bone to soft tissue. ***PMID 10696570*** · *Sapolsky 2000*

Lead, aluminium, and cadmium: mimic calcium at cellular uptake sites and accumulate in bone. ***PMID 12777158*** · *Patrick 2003*

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Studies of patients in chronic widespread pain research cohorts have reported higher hair calcium and magnesium than healthy controls, with tissue retention or mineral maldistribution described as a contributing pattern.

: Women in the highest hair-calcium quartile have shown lower dietary calcium intake and reduced lumbar-spine bone density. The pattern has been described as bone calcium shifting into soft tissues.

: Regional studies have reported that areas with higher average hair calcium showed markedly lower cardiovascular mortality, with a substantial fraction of geographic variation tracking this gradient.

: Imaging studies have reported that higher hair calcium correlated with reduced coronary calcium scores on CT.

: Studies of middle-aged adults have reported an elevated hair Ca:Mg ratio appearing alongside greater presence and extent of subclinical vascular calcium deposition.

JOHN SMITH

MAGNESIUM (Mg) HIGH · OUT OF RANGE

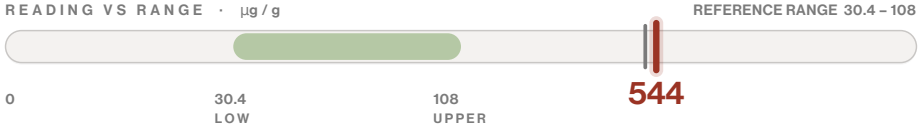
The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

12 24.305
Mg
Magnesium
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 30.4 – 108



Reference range · Current 544 µg/g · *Previous 482 µg/g*

SCAN FOR REFERENCED LITERATURE

Magnesium is the principal inhibitory macromineral, supporting 300+ enzymatic reactions, ATP generation, and neuromuscular relaxation.

In the mineral-balancing literature, magnesium has been described as parallel to calcium, a slow-acting sedative mineral; elevation has been reported not as nutritional sufficiency but as a compensatory pattern, with Mg retained in tissue when cellular utilization is impaired or when inhibitory dominance is required to counter sustained sympathetic stress. The literature has described high hair magnesium most commonly in slow-oxidation states with reduced adrenal output, where the body leans on Mg for membrane stability and excitability control. Hair magnesium is read alongside its relationships with calcium, sodium, and phosphorus.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Oxidation rate & adrenal tone	An elevated magnesium reading has been associated in hair-analysis practice with a slow-oxidation pattern and reduced adrenal output, where Mg is retained alongside calcium as an inhibitory 'shell' while sodium and potassium fall. It has been read holistically against the Na:Mg 'adrenal ratio' and the parasympathetic markers rather than as nutritional sufficiency. ***Wilson L — HTMA slow-oxidation magnesium-retention convention***	Magnesium Shell · Parasympathetic Dominance · Oxidizer Type: Slow/Extreme Slow · Bio-unavailable Ca and Mg · Mg 544 (▲) · Ca 4,366 (▲) · Na:Mg 3.01 (·)
Acid-base buffering & bone reserve	Magnesium retention has been linked with the skeletal mineral reservoir and acid-base buffering, magnesium rising together with calcium, strontium, and barium as the alkaline-earth group elevates under sustained buffering demand. Research has associated the magnesium-bone relationship with mineralisation and the body's capacity to neutralise metabolic acid load. ***PMID 33959846***	Reduced Buffering Capacity · Bio-unavailable Ca and Mg · Mg 544 (▲) · Ca 4,366 (▲) · Ca:Mg 8.03 (·) · Mg:P 4.09 (▲) · Sr 12.3 (▲)
Neuromuscular inhibition	Elevated magnesium has been associated with its role as the principal inhibitory mineral at the cell membrane, where research has shown magnesium modulating the Na/K-ATPase pump and stabilising neuromuscular excitability. In tissue it has been read alongside calcium and the macromineral group as a marker of sedative, relaxation-favouring dominance. ***PMID 28124894***	Four-High · Parasympathetic Dominance · Mg 544 (▲) · Ca 4,366 (▲) · Ca:Mg 8.03 (·) · K 517 (▲) · Na 1,638 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Vitamin B6 (pyridoxine): facilitates intracellular magnesium transport and red-blood-cell uptake. ***PMID 7271227*** · *Abraham 1981*

Magnesium directly: modulates the Na/K-ATPase pump and intracellular ion balance. ***PMID 28124894*** · *Apell 2017*

Vitamin D activation requires Mg-dependent enzymes; the two work as a reciprocal pair. PMID 29480918 · Uwitonze et al. 2018

Dietary protein: supplies amino acids and ATP-Mg binding sites for cellular Mg pools. PMID 25540137 · de Baaij et al. 2015

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Studies of patients in chronic widespread pain research cohorts have reported significantly higher hair magnesium and calcium than healthy controls, with tissue retention or maldistribution described as the pattern.

: Children in dyslexia research cohorts have shown elevated hair magnesium compared to neurotypical children.

: Children in Prader-Willi syndrome research cohorts have shown significantly raised hair magnesium, consistent with altered mineral regulation.

: Patients in acute ischemic stroke research cohorts have shown significantly higher hair magnesium than healthy controls.

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SODIUM (Na) HIGH · OUT OF RANGE

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11 22.990

Na

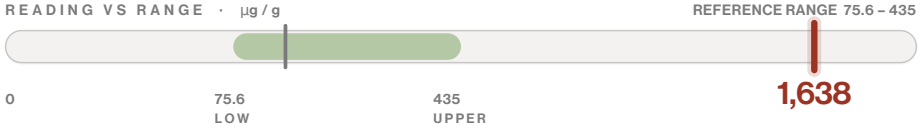
Sodium

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 75.6 – 435



Reference range · Current 1,638 µg/g · Previous 158 µg/g

SCAN FOR REFERENCED LITERATURE

Sodium is the principal sympathetic and adrenal-driven macromineral, supporting fluid regulation, blood pressure stability, nerve conduction, and adrenal cortical signalling.

In the mineral-balancing literature, sodium has been described as a stress and activation marker rather than a reflection of salt intake. The literature has described elevated Na as a sign of alarm-phase physiology: the body retains Na under sympathetic drive to maintain circulation and short-term resilience. The pattern has been read most meaningfully against potassium (the Na:K ratio is the primary stress ratio in the literature) and against Ca and Mg, which buffer Na's excitatory influence.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Adrenal & stress response	An elevated sodium reading has been associated with alarm-stage adrenal activity, where cortical output and aldosterone signalling mobilise sodium for an acute stress response. It is read holistically against potassium and the stress ratios rather than in isolation. ***PMID 35202970***	Sympathetic Dominance · Oxidizer Type: Fast/Extreme Fast · Na:K 3.17 (▲) · K 517 (▲) · Na:Mg 3.01 (·) · Mg 544 (▲)
Fluid balance & blood pressure	Sodium retention is mineralocorticoid-driven — aldosterone holds sodium while wasting potassium — so an elevated reading has been linked with fluid retention and vascular strain. It is evaluated alongside potassium, the Na:K balance, and the calcium and magnesium buffers. ***PMID 36994769***	Na 1,638 (▲) · K 517 (▲) · Na:K 3.17 (▲) · Ca 4,366 (▲) · Mg 544 (▲)
Oxidation rate & metabolism	In hair-analysis practice sodium is read as a fast-oxidation energy marker, with the Na:Mg "adrenal ratio" and Ca:K "thyroid ratio" framing metabolic tempo; an elevated reading has been described as part of a fast-oxidation pattern. ***Watts DL, Trace Elements Inc. — HTMA oxidation-rate convention***	Oxidizer Type: Fast/Extreme Fast · Na:Mg 3.01 (·) · Ca:K 8.45 (▲) · Ca 4,366 (▲) · Mg 544 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Potassium: balance maintains the Na/K-ATPase pump and the membrane gradient regulating Na. ***PMID 24721891*** · *Palmer 2015*

Magnesium: supports endothelial function and Mg-dependent ATPase activity downstream of Na load. PMID 25540137 · de Baaij et al. 2015

Dietary protein: supplies the amino acid precursors for aldosterone synthesis and Na transport proteins. ***PMID 11916747*** · *Heaney 2002*

ANTAGONISTS

Chronic stress: drives glucocorticoid and aldosterone output, increasing renal Na retention. ***PMID 10696570*** · *Sapolsky 2000*

High salt intake from processed food contributes to hypertension and Na retention. ***PMID 27757935*** · *Rust 2017*

Low potassium intake inverts the Na: K ratio and compounds Na dominance. Watts DL, Trace Elements Inc. 1995

Cadmium exposure (smoking, occupational) contributes to elevated blood pressure and sodium handling. PMID 35257333 · Aramjoo et al. 2022

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Elevated hair sodium has been reported alongside higher BMI, abdominal obesity, body-fat percentage, and visceral-fat area in metabolic-syndrome research.

: High hair sodium has tracked with elevated serum insulin and HOMA-IR scores, indicating impaired glucose metabolism and insulin sensitivity in observational studies.

: Increased hair sodium has been reported alongside higher systolic blood pressure and observed in hypertensive research populations.

: Elevated hair sodium has been reported alongside higher triglycerides and lower HDL cholesterol in observational studies.

JOHN SMITH

POTASSIUM (K) **HIGH · OUT OF RANGE**

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19 39.098

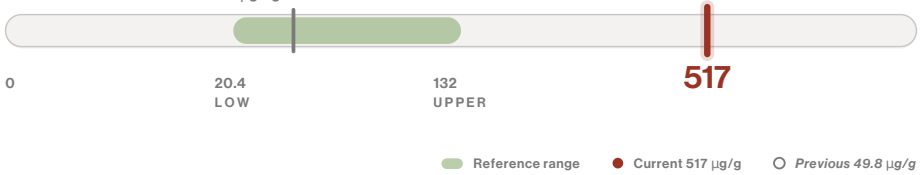
K

Potassium

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



SCAN FOR REFERENCED LITERATURE

Potassium is the primary intracellular cation, supporting nerve and muscle function, cardiac rhythm, glucose handling, and thyroid effect at the tissue level.

In the mineral-balancing literature, K has been described as a thyroid and catabolic-activity marker rather than a reflection of intake. The literature has described elevated K most often in stress-activated and catabolic states, where K has been observed to release from tissue under sympathetic and thyroid influence. Hair potassium is read alongside the Na:K ratio (stress) and the Ca:K ratio (a primary indicator of thyroid effect in the literature).

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Adrenal & stress response	An elevated potassium reading has been associated with alarm-stage adrenal activity, where sympathetic and adrenocortical drive mobilise intracellular K alongside sodium during an acute stress response. It is read holistically against the Na:K stress ratio and the oxidation pattern rather than in isolation. ***PMID 10696570***	Sympathetic Dominance · Oxidizer Type: Fast/Extreme Fast · Na:K 3.17 (▲) · K 517 (▲) · Na 1,638 (▲)
Thyroid & metabolic rate	In hair-analysis practice elevated potassium has been read as a marker of heightened thyroid effect at the tissue level, with the Ca:K 'thyroid ratio' framing a fast metabolic tempo. The reading has been interpreted against calcium and the oxidation type rather than as a reflection of intake. ***Watts DL, Trace Elements Inc. — Ca:K thyroid-ratio convention***	Oxidizer Type: Fast/Extreme Fast · Ca:K 8.45 (▲) · K 517 (▲) · Ca 4,366 (▲) · Na:K 3.17 (▲)
Cellular handling & catabolism	Elevated potassium has been linked with catabolic tissue release, where intracellular K shifts into circulation under protein breakdown, prolonged stress, or impaired membrane handling, often paralleled by phosphorus from the same process. Magnesium and the K:Mg ratio frame the cellular-transport reading. ***PMID 24721891***	Four-High · K 517 (▲) · P 133 (·) · K:Mg 0.950 (·) · Mg 544 (▲) · Ca:P 32.9 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Sodium: balance maintains the Na/K-ATPase pump and the adrenal Na:K signalling axis. Watts DL, Trace Elements Inc. 1995

Magnesium directly: modulates the Na/K-ATPase that holds K intracellularly. ***PMID 28124894*** · *Apell 2017*

Vitamin B6: supports cellular membrane transport including the Na/K-ATPase. ***PMID 7271227*** · *Abraham 1981*

ANTAGONISTS

Tissue catabolism (illness, fasting, post-stress) releases intracellular K into circulation. ***PMID 24721891*** · *Palmer 2015*

Low magnesium impairs Na/K-ATPase activity, driving K out of cells. ***PMID 28124894*** · *Apell 2017*

Aldosterone deficiency: reduces renal K excretion, allowing K accumulation. ***PMID 25905305*** · *Feingold 2000*

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Higher hair potassium has been reported alongside metabolic syndrome, obesity, and elevated BMI in observational studies, often rising in parallel with sodium under metabolic stress.

: Elevated hair potassium has been described as a cardiovascular-strain marker and frequently observed in patients in coronary and hypertensive research cohorts.

: Significant K elevations have been documented in men in prostate-disease research cohorts (BPH and prostate cancer), reflecting altered endocrine and mineral regulation.

Atopic-dermatitis cohorts: Patients in atopic-dermatitis research have shown higher hair potassium, likely from systemic stress of chronic inflammation. ***PMID 25192728*** · *Wacewicz et al., 2014*

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

24 51.996

Cr

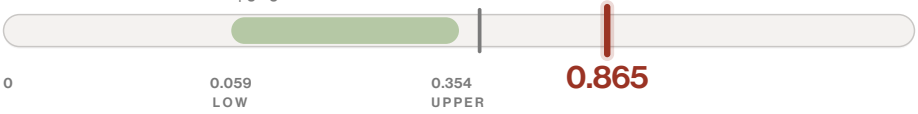
Chromium

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 0.059 – 0.354



Reference range · Current 0.865 µg/g · *Previous 0.408 µg/g*

SCAN FOR REFERENCED LITERATURE

Chromium is a trace mineral with a specialised role in insulin-mediated glucose transport and carbohydrate utilization.

In HMA, elevated Cr has not typically been described as a marker of nutritional sufficiency; the literature has described it most often in glucose regulation under strain, where Cr turnover increases and tissue Cr is mobilised. Industrial and occupational exposure has been described as the other main interpretive context.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Glucose & insulin metabolism	An elevated chromium reading has been associated with compensatory mobilisation of tissue stores under glucose dysregulation, where research has linked insulin signalling strain to increased chromium turnover and urinary loss. It has been read holistically against the insulin-cofactor minerals and the Mg:P ratio rather than as a marker of sufficiency. ***PMID 15208835***	Cr 0.865 (▲) · Mg 544 (▲) · Zn 121 (▼) · Mg:P 4.09 (▲) · Mn 0.237 (·)
Exposure & body burden	An elevated chromium reading has been associated with chronic occupational or environmental intake from tanning, electroplating, welding, drinking water, or tobacco, where studies have used hair chromium as a long-term biomarker of cumulative exposure. It has been read alongside the other accumulated metals to gauge total body burden. ***PMID 25268509***	Cr 0.865 (▲) · Pb 22.8 (▲) · Cd 0.008 (·) · Mn 0.237 (·) · Ca:Pb 192 (▼) · Ca:Cd 545,750 (·)
Trace-mineral cofactor synergy	An elevated chromium reading has been associated with supplementation or with disturbed handling of the trace-mineral pool that incorporates chromium into chromodulin, where research has linked zinc, manganese, and magnesium to the insulin-receptor pathway chromium amplifies. It has been read against these partner minerals to distinguish intake from physiological imbalance. ***PMID 11472024***	Cr 0.865 (▲) · Zn 121 (▼) · Mn 0.237 (·) · Mg 544 (▲) · Mo 0.193 (▲) · Cu:Mo 193 (·)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Zinc and Mn support enzymes that incorporate Cr into chromodulin.

Magnesium: is required for insulin receptor autophosphorylation, the pathway Cr amplifies.

B vitamins (B1, B3, biotin) and vitamin C support glucose-handling enzymes.

ANTAGONISTS

Hexavalent Cr exposure (industrial water, cement work) drives toxic accumulation.

Long-term high-dose Cr picolinate: exceeds regulatory capacity and drives accumulation.

Tobacco: delivers chronic low-level Cr alongside other heavy metals.

Stainless steel cookware leaches Cr into acidic foods during prolonged cooking.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Significantly elevated hair Cr in leather tanning workers vs. unexposed controls, a direct biomarker of chronic Cr(III) exposure from workplace compounds.

: Hair Cr is approximately 51% higher in obese adults vs. normal-weight controls, reflecting potential shifts in mineral distribution under metabolic load.

: Women with GDM show markedly higher hair Cr than nondiabetic pregnant women, indicating impaired tissue utilization.

: High-dose Cr brewer's-yeast supplementation increases hair Cr by 20.6% in T2DM patients, paralleling improved intake and metabolic markers.

: Elderly T2DM patients exhibit a wider distribution of hair Cr values, including higher outliers, attributed to compensatory mobilization during glucose dysregulation.

JOHN SMITH

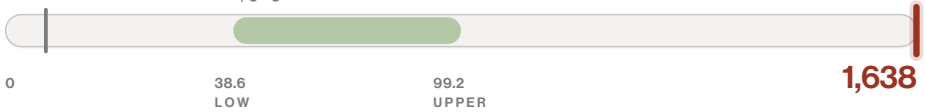
SILICON (Si) **HIGH · OUT OF RANGE**

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

14 28.086
Si
Silicon
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



Reference range · Current 1,638 µg/g · Previous 9.12 µg/g

SCAN FOR REFERENCED LITERATURE

Silicon is a structural trace element supporting collagen synthesis, connective tissue elasticity, bone matrix formation, and the directed deposition of calcium into bone rather than soft tissue.

In HMA, silicon has been read carefully because hair Si is heavily influenced by external contamination: silicones in conditioners, shampoos, and styling products. Elevated hair Si has rarely been described as a marker of internal sufficiency. The literature has also recognised elevated Si during active aluminium detoxification, since silicic acid binds aluminium.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
External contamination & hair products	An elevated hair silicon reading has most often been associated with external contamination rather than tissue sufficiency, as silicones in conditioners, shampoos, and styling treatments deposit on the shaft and read markedly higher in women. It has been interpreted holistically against the absence of any concurrent aluminium-clearance pattern before tissue significance is considered. ***Watts DL, Trace Elements Inc. — HTMA silicon external-contamination convention***	Si 1,638 (▲) · Al 11.1 (·) · Ca 4,366 (▲) · Mg 544 (▲) · B 3.33 (▲)
Aluminium clearance & detox	Elevated silicon has been linked with active aluminium clearance, where silicic acid forms aluminosilicate complexes that lower aluminium bioavailability and promote its excretion. It has been read alongside the patient's aluminium status and surrounding mineral context rather than as an isolated number. ***PMID 22976072***	Si 1,638 (▲) · Al 11.1 (·) · Ca 4,366 (▲) · Mg 544 (▲) · P 133 (·)
Environmental & dietary loading	Elevated silicon has been associated with sustained environmental or occupational exposure to dust, clay, and industrial silica, and with heavy intake of silica supplements or silicon-rich mineral water. Research has framed silicon as a long-term exposure biomarker read holistically against connective-tissue minerals. ***PMID 25081495***	Si 1,638 (▲) · Al 11.1 (·) · Ca 4,366 (▲) · B 3.33 (▲) · Mg 544 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Si: supports collagen crosslinking and bone matrix alongside Ca, Mg, and B.

Vitamin C: drives proline/lysine hydroxylation in the collagen matrix Si stabilizes.

Boron pairs with Si in connective tissue mineral organization.

Magnesium: supports collagen synthesis enzymes that incorporate Si into matrix.

ANTAGONISTS

Silica supplementation (orthosilicic acid, horsetail, diatomaceous earth) is the most common driver.

Heavy Si-rich mineral water (some European brands deliver 30+ mg/L) produces chronic mild elevation.

Occupational Si exposure (mining, sandblasting, construction, foundry) carries pulmonary risk.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Elevated hair Si is most commonly external contamination from hair care products (silicones in conditioners, shampoos, shine treatments) rather than tissue sufficiency, often showing much higher levels in females.

: Elevated Si is a primary marker for active mobilization and clearance of aluminium. Silicic acid reduces aluminium bioavailability and helps prevent deposition in sensitive tissues.

: Significantly elevated hair Si is a reliable long-term biomarker of chronic exposure from dust, clay, industrial materials, or environmental sources.

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JOHN SMITH

STRONTIUM (Sr) HIGH · OUT OF RANGE

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

38 87.62

Sr

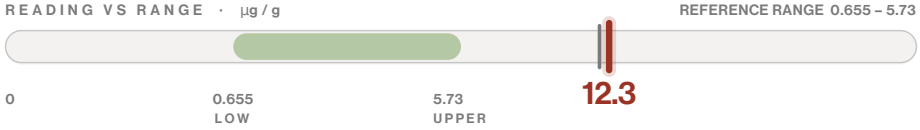
Strontium

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 0.655 – 5.73



Reference range · Current 12.3 µg/g · *Previous 11.6 µg/g*

SCAN FOR REFERENCED LITERATURE

Strontium is a trace alkaline-earth metal that closely parallels calcium in bone and soft tissue, substituting for calcium within hydroxyapatite.

In HMA, Sr has been read alongside the broader alkaline-earth group (Ca, Mg, Ba) and has not been given an independent regulatory role. The literature has described elevated hair Sr primarily in environmental exposure, alkaline-earth pooling in slow oxidation, or supplemental intake.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Bone & alkaline-earth deposition	An elevated strontium reading has been associated with the alkaline-earth pool that mineralises bone, where strontium substitutes for calcium in the hydroxyapatite lattice and signals through the calcium-sensing receptor. It has been read holistically against calcium and magnesium and the Ca:Sr ratio rather than in isolation. ***PMID 34207344***	Sr 12.3 (▲) · Ca 4,366 (▲) · Ca:Sr 355 (·) · Mg 544 (▲) · Ca:Mg 8.03 (·) · Ca:P 32.9 (▲)
Environmental exposure & intake	Elevated hair strontium has been linked with sustained intake from strontium-rich drinking water, soil, or regional diet, where studies suggested geographic variation in exposure and a positive relationship with bone mineral density. It has been framed against calcium and the Ca:Sr ratio to gauge whether the rise reflects burden or proportionate alkaline-earth status. ***PMID 33432414***	Sr 12.3 (▲) · Ca:Sr 355 (·) · Ca 4,366 (▲) · Mg 544 (▲) · P 133 (·)
Acid-base buffering reserve	In hair-analysis practice an elevated strontium reading has been interpreted as part of the broader Ca-Mg-Sr alkaline-earth pattern that buffers sustained acid-base demand, often appearing alongside reduced buffering capacity. It has been read together with calcium, magnesium and the calcium ratios that frame mineral availability. ***Watts DL, Trace Elements Inc. — HTMA alkaline-earth buffering convention***	Reduced Buffering Capacity · Sr 12.3 (▲) · Ca 4,366 (▲) · Mg 544 (▲) · Ca:Mg 8.03 (·) · Ca:P 32.9 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Sr and Ca: share absorption and tissue deposition pathways; balance preserves Ca:Sr.

Dietary protein: supplies amino acids for the collagen matrix Sr is mineralized into.

Vitamin K2: directs Sr (alongside Ca) into bone rather than soft tissue.

Magnesium pairs with Sr as alkaline-earth metals in bone matrix organization.

ANTAGONISTS

Sr supplementation (Sr citrate, Sr ranelate) for bone density is the most common modern driver.

Sr-rich drinking water (parts of the central US, agricultural areas) drives chronic exposure.

Long-term high-dairy intake from Sr-rich pastures can produce modestly elevated patterns.

Radiogenic Sr-90 from legacy fallout is rare but worth considering with documented exposure.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Elevated hair Sr is observed in individuals with significant coronary artery lesions, an indicator of cardiovascular strain and mineral-related vascular stress.

: Higher hair Sr is noted in patients with advanced atherosclerosis, potentially reflecting underlying mineral imbalance or adaptive response in vascular tissues.

: Significantly elevated hair Sr is a reliable long-term biomarker of chronic exposure from Sr-rich drinking water, soil, or dietary sources in certain geographic regions.

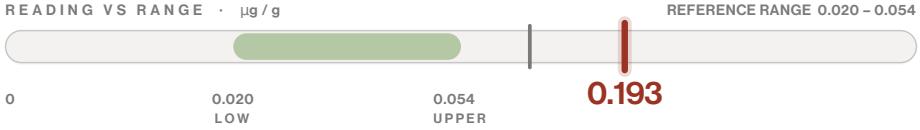
The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

42 95.95
Mo
Molybdenum
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE 0.020 – 0.054



SCAN FOR REFERENCED LITERATURE

Molybdenum is an essential trace cofactor supporting sulfite oxidation, aldehyde metabolism, and purine breakdown, placing it at the intersection of sulfur metabolism, detoxification, and copper regulation.

In HMA, Mo has been read alongside copper as one of its most important antagonists. Elevated hair Mo has been described primarily in supplementation contexts (often to mobilise excess copper), environmental exposure, or detoxification activity.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Copper regulation & antagonism	An elevated molybdenum reading has been associated with stronger copper antagonism, since research has shown that added molybdenum reduced copper availability and that molybdate compounds lowered circulating copper in humans. It is read holistically against copper and the Cu:Mo ratio rather than in isolation, with a watch for secondary copper depletion. ***PMID 38081365***	Mo 0.193 (▲) · Cu 37.2 (▲) · Cu:Mo 193 (·) · Zn:Cu 3.25 (▼) · Fe:Cu 0.629 (·)
Sulfur & detox metabolism	Higher molybdenum has been linked to the cofactor enzymes that oxidise sulfite, metabolise aldehydes, and process purines, so studies have framed it within sulfur amino-acid catabolism and detoxification load. It is read alongside sulfur and the Cu:Mo ratio as a marker of active sulfite and aldehyde handling. ***PMID 38187804***	Mo 0.193 (▲) · S 43,239 (·) · Cu:Mo 193 (·) · S:Cu 1,163 (▼) · Cu 37.2 (▲)
Exposure & body burden	Elevated hair molybdenum has been described as a long-term biomarker integrating dietary, water, and occupational sources, and reviews have treated trace-metal hair levels as reflecting cumulative exposure windows. It is read together with the toxic-metal panel and the Cu:Mo ratio to separate supplementation from environmental load. ***PMID 37337116***	Mo 0.193 (▲) · Cu:Mo 193 (·) · S 43,239 (·) · Cd 0.008 (·) · Pb 22.8 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Methionine and cysteine supply sulfur for Moco biosynthesis and sulfite oxidase.

Iron pairs with Mo in xanthine and aldehyde oxidase; Zn supports the broader enzyme network.

Sustained protein intake: supports albumin and alpha-2-macroglobulin Mo transport.

ANTAGONISTS

Hard water with high Mo content is an underappreciated chronic source.

Mo supplementation for sulfur intolerance or Cu-lowering can push Mo into elevation.

Industrial exposure (metallurgy, steel alloys, lubricants) drives occupational Mo loads.

Low Cu removes the reciprocal Mo-Cu interaction that limits Mo retention.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: A significant proportion of children with neurodevelopmental disorders (especially autism) show Mo overload in hair, particularly in younger age groups, often co-occurring with zinc deficiency.

: Higher hair Mo is inversely correlated with cognitive function (full-scale IQ) and overall symptom severity in children with ASD.

: Elevated Mo strongly inhibits copper absorption and tissue utilization, which can lead to secondary copper deficiency patterns observed in HMA.

: Elevated hair Mo is a reliable long-term biomarker of chronic exposure from Mo-rich soil, water, mining, or industrial sources.

Sample ID **HMA250012** Prev Sample **HMA240008** Practitioner **Dr. John Doe (200)**

DOB **1985-06-15** Collected **2026-06-20** Received **2026-06-23** Report **2026-06-25**

NUTRITIONAL ELEMENTS

HIGH IRON (Fe)

READING **23.38** µg/g

REFERENCE RANGE **6.45–22.0** µg/g

Hair iron is unreliable for systemic status â€" confirm with **ferritin and transferrin saturation** before any interpretation that affects supplementation. Takes priority when aligned with fatigue not responding to typical supports, joint stiffness, unusual skin bronzing, or a family history of hemochromatosis. Elevated Fe with low Cu on hair sometimes points to **functional iron mishandling** (copper is required for iron loading onto transferrin) rather than true iron excess. **Never restrict iron on hair alone.** Donating blood is a simple first-line step when labs confirm elevation with clinical match.

HIGH COPPER (Cu)

READING **37.18** µg/g

REFERENCE RANGE **9.26–28.0** µg/g

Biounavailable copper accumulating in tissues while the ceruloplasmin-bound functional form may still be inadequate â€" copper excess and functional deficiency can coexist. Anxiety, mood lability, fatigue with cold extremities, and heavy or intensely premenstrual periods in women fit. **Estrogen-dominant states** (oral contraceptives, HRT, perimenopause) and copper plumbing are the common drivers. **Serum ceruloplasmin** with a copper-to-ceruloplasmin ratio calculation settles functional status â€" the raw hair value alone doesn't. Support with **zinc, molybdenum, and vitamin C** to mobilise unbound copper, rather than dietary copper restriction alone.

LOW ZINC (Zn)

READING **120.8** µg/g

REFERENCE RANGE **123–234** µg/g

Either **increased demand** (growth, pregnancy, recovery from illness) or **chronic GI loss** from low stomach acid, malabsorption, or stress-driven burn. Slow wound healing, skin changes (acne, eczema flares), reduced immune resilience, or loss of taste/smell acuity fit; in men, fertility-related concerns may accompany. Worth taking seriously even at this level â€" zinc sits at the centre of immune, wound-healing, and hormonal function. Check **Zn/Cu** and GI history. **Picolinate or bisglycinate** forms are well-tolerated; pair with adequate copper to preserve ratio balance.

LOW SELENIUM (Se)

READING **0.461** µg/g

REFERENCE RANGE **0.532–1.09** µg/g

Reduced **antioxidant and thyroid-conversion reserves** rather than an acute problem. Fatigue, reduced immune resilience, dry or brittle hair and nails, and â€" on labs â€" impaired T4-to-T3 conversion fit. **Brazil nuts (1-2/day)** is usually sufficient dietary support; selenomethionine supplementation when dietary shifts aren't feasible or thyroid antibodies are elevated. Check **Zn/Se and Cu/Se ratios** for antioxidant-system context.

Entries shown mildly out of reference range — see bar chart on page 1 for context.

Sample ID **HMA250012** Prev Sample **HMA240008** Practitioner **Dr. John Doe (200)**

DOB **1985-06-15** Collected **2026-06-20** Received **2026-06-23** Report **2026-06-25**

NUTRITIONAL ELEMENTS

HIGH BORON (B)

READING	REFERENCE RANGE
3.33 µg/g	**0.543–2.33** µg/g

Almost always **supplementation or mineralised water** â€" joint-support formulas and bone-health products are common sources. Rarely clinically actionable at this level. Watch for occasional mild GI symptoms at higher intakes.

Entries shown mildly out of reference range — see bar chart on page 1 for context.

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JOHN SMITH

CALCIUM SHELL PATTERN · IDENTIFIED

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SCAN FOR REFERENCES

✓

PATTERN

● IDENTIFIED

HAIR MINERAL ANALYSIS · PATTERN REFERENCE

Calcium Shell Pattern

CA/K CA/NA CA/P

A calcium shell describes a hair mineral pattern with markedly elevated calcium relative to typical ranges.

Calcium supports cellular membrane stability, electrical signaling, and bone/connective tissue integrity. Elevated hair calcium over time indicates tissue deposition linked to slower mineral exchange and reduced cellular activation. Elevated hair calcium does not imply excess dietary intake; it reflects tissue retention due to low cellular energy, impaired transport, and biounavailability, often in chronic stress or slow oxidation contexts.

Excess tissue calcium acts as a cellular "brake," reducing membrane permeability and responsiveness to sodium-driven stimulation. This dampens excitability, promoting containment and insulation from excessive demands, and shifts physiology toward reduced pace and energy conservation. The pattern represents a longer-term adaptive response to sustained stress or low energy availability, prioritizing defense and regulation.

These ratios assess thyroid responsiveness, adrenal vitality, and tissue-level metabolic rate. Calcium shells often follow prolonged sympathetic dominance (chronic stress/fight-or-flight), transitioning to parasympathetic dominance with withdrawal. Mobilization during rebalancing can temporarily increase symptoms as calcium re-enters circulation. Phosphorus depletion/low energy production frequently underlies retention by limiting mineral mobilization.

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Psychological Withdrawal and Defensiveness: Emotional withdrawal, protection, rigidity, introversion, reduced engagement, numbness, apathy, detachment, loss of sexual desire, and a protective shell against chronic stress/trauma/overwhelm. ***PMID 35379283*** · *Christensen MC 2022*

Metabolic Suppression and Fatigue: Slow oxidation, functional hypothyroidism-like states, reduced energy production, chronic fatigue, adrenal depletion, hypoglycemia, and energy conservation. ***PMID 24692351*** · *Mullur R 2014*

Tissue Rigidity and Motility Issues: Joint/muscle stiffness, reduced smooth muscle motility (constipation, slow digestion), dry skin/hair, low gastric acid, potential fibromyalgia/chronic pain contributions. ***PMID 38803365*** · *Xu GM 2024*

Mood and Cognitive Effects: Depressive tendencies, emotional flattening, brain fog, reduced sharpness, anxiety/despair in protective contexts, emotional inhibition/numbness from dampened excitability. ***PMID 24285104*** · *Duntas LH 2013*

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FOUR HIGHS PATTERN · IDENTIFIED

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SCAN FOR REFERENCES

✓

PATTERN

● IDENTIFIED

HAIR MINERAL ANALYSIS · PATTERN REFERENCE

Four Highs Pattern

The Four Highs pattern in hair mineral analysis occurs when calcium, magnesium, sodium, and potassium are all elevated above their ideal reference ranges.

This is inherently contradictory: high sodium and potassium reflect fast oxidation, adrenal activation, sympathetic dominance, and acute stress, while high calcium and magnesium indicate slow oxidation, metabolic slowing, and cellular stabilization. The coexistence of these opposing states signals physiological conflict and high adaptive demand. Elevated hair levels typically represent bio-unavailability, minerals mobilized from tissues but poorly utilized at the cellular level, resulting in excretion or deposition in hair, rather than abundant, functional stores. The pattern therefore points to tissue dysregulation, increased mineral turnover, and an underlying stress response or metabolic transition.

These conflicting dynamic places considerable strain on regulation systems. The body has to simultaneously address the adrenal and sympathetic activation driven by high sodium and potassium while depending on calcium and magnesium to stabilize cell membranes, moderate excitability in tissues, and support essential enzymatic functions. As a result, a large portion of available energy is directed toward maintaining kidney electrolyte balance, endocrine modulation, and autonomic equilibrium rather than supporting efficient metabolism, repair, or recovery. In nutritional balancing literature, this is commonly described as a slow oxidizer under stress. It represents a sluggish or depleted metabolic baseline overlaid by a secondary alarm reaction, which often produces volatile or inconsistent symptoms and contributes to accelerated mineral wasting or sequestration despite the apparently high tissue readings.

Na/K ratio: usually elevated, pointing to ongoing stress or inflammation Ca/Mg ratio: indicates blood sugar stability and carbohydrate metabolism tendencies Na/Mg ratio: reflects short-term adrenal drive or effort Ca/K ratio: offers clues about thyroid influence The oxidation rate can appear mixed due to the blend of fast and slow features, but it is generally viewed as underlying slow oxidation with an acute stress overlay. Hidden toxic metals often interfere with these relationships and add complexity. The Four Highs pattern is typically unstable and temporary. Sodium and potassium often decline first as acute stress subsides, unmasking underlying slow oxidation or depletion. Serial retesting is essential to track whether the pattern resolves, supports detoxification, undergoes metabolic reorganization, or progresses toward deeper exhaustion if stressors persist.

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Secondary Alarm Reaction / Slow Oxidizer Under Stress: Acute stress response (elevated Na, K) overlaid on slow oxidation or exhaustion (elevated Ca, Mg), producing a "tired but wired" state with high adrenal, kidney, and autonomic strain.

Hidden Toxic Metal Burden (Especially Copper): Often linked to hidden toxic metals, especially copper toxicity, plus aluminum, cadmium, mercury, manganese, or iron. Retests may reveal more as the pattern resolves, signaling detoxification progress.

Psychological or Emotional Defensiveness: Biochemical "defensive" posture: stilted, ungrounded, guarded, or emotionally compensatory in response to deep stressors, trauma, or chronic fatigue; may include anxiety, instability, or guarded mood.

Potential Links to Metabolic or Cardiovascular Risk: Hair macromineral levels (Ca, Mg, Na, K) reflect long-term trends; altered Na/K associated with ASCVD risk in studies, though not as a specific "four highs" pattern. ***PMID 30884739*** · *Choi HI 2019*

Associations with Inflammatory or Stress-Related States: Elevated hair Na and K (variable Ca/Mg) noted in metabolic syndrome, inflammation, or stress states in limited research; combined four-macromineral elevation lacks peer-reviewed pattern validation. ***PMID 19221698*** · *Park SB 2009*

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JOHN SMITH

REDUCED BUFFERING CAPACITY · IDENTIFIED

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SCAN FOR REFERENCES

✓

PATTERN

● IDENTIFIED

HAIR MINERAL ANALYSIS · PATTERN REFERENCE

Reduced Buffering Capacity

A reduced buffering capacity pattern is identified when calcium (Ca), magnesium (Mg), strontium (Sr), and barium (Ba) are elevated in hair relative to reference ranges.

These alkaline earth minerals share chemical similarities and codeposit in bone hydroxyapatite, contributing to structural stability and tissue buffering. Nutritional balancing and excretion pathway literature demonstrates that systemic pH strongly influences the mobilization, retention, and excretion of these structural minerals. When this group is elevated together over time, the pattern reflects sustained tissue retention of alkaline minerals as the body reinforces buffering capacity in response to pH regulatory demands, with reduced emphasis on rapid mineral turnover.

Chronic dietary acid load or low grade metabolic acidosis causes bone to release alkaline earth minerals, primarily calcium and magnesium, to buffer excess protons. This increases urinary excretion while promoting compensatory tissue retention and matrix stabilization. Strontium and barium follow parallel ionic pathways and substitute within hydroxyapatite. Hair mineral analysis reflects this long term pattern when buffering mechanisms are chronically engaged. The profile is associated with membrane stabilization, slower metabolic reactivity, and reduced short term adaptability.

Major mineral ratios (Ca/Mg, Na/K, Ca/P) help determine the dominant influence (metabolic slowing, structural prioritization, or pH driven buffering) Broader macromineral trends provide insight into overall mineral allocation and compensatory mechanisms Hair mineral analysis offers a longitudinal view of how alkaline mineral reserves are maintained or reinforced under sustained acid base stress

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

pH Effects on Structural Elements and Excretion Pathways: Acid forming diets or increased net acid excretion stimulate bone resorption and elevate urinary calcium excretion (for example, up to 74% higher in controlled trials), with related alkaline earth minerals showing parallel behavior due to shared regulatory and deposition pathways. ***PMID 11446566*** · *Buclin T 2001*

Link to Osteoporosis: Chronic skeletal calcium mobilization for buffering leads to negative calcium balance, progressive demineralization, reduced bone mineral density, and increased osteoporosis risk. ***PMID 11842949*** · *Bushinsky DA 2001*

Correlation with Laboratory Observations: These pH driven mechanisms correlate with our lab findings of concurrent elevations in Ca, Mg, Sr, and Ba, reflecting long term compensatory tissue retention and reinforced structural buffering under sustained acid base stress.

CanAlt Health Laboratories

JOHN SMITH

BIO-UNAVAILABLE CALCIUM AND MAGNESIUM · IDENTIFIED

Information on this page is provided for educational and reference purposes only — drawn from the published mineral balancing literature — and should not be relied upon as the basis for clinical diagnosis or treatment decisions.

SCAN FOR REFERENCES

✓

PATTERN

● IDENTIFIED

HAIR MINERAL ANALYSIS · PATTERN REFERENCE

Bio-Unavailable Calcium and Magnesium

ELEVATED CA AND MG | CA/MG RATIO | LOW NA/K RATIO

A bio-unavailable calcium and magnesium pattern is identified in hair mineral analysis (HMA) when calcium and magnesium levels are markedly elevated.

These high tissue concentrations reflect deposition into the hair shaft and soft tissues rather than remaining bioavailable, soluble, and functionally active in blood and cells. The pattern frequently appears with slow oxidation and low sodium/potassium, representing a compensatory response to prolonged stress, adrenal/thyroid insufficiency, impaired mineral solubility, or chronic low-grade acid–base imbalances.

Insufficient sodium and potassium impair the solubility of calcium and magnesium, leading to precipitation and accumulation in non-functional sites (arteries, joints, kidneys, connective tissue). This creates functional bio-unavailability, where ongoing bone mobilization maintains serum levels but perpetuates depletion and reduced mineral effectiveness. Hair mineral analysis (HMA) captures chronic tissue deposition over months, often linked to lowered metabolic rate, persistent fatigue, protective stress adaptations, and increased soft-tissue calcification risk.

Hair mineral analysis (HMA) provides a longitudinal view of chronic mineral handling, showing sustained deposition from prolonged stress, poor elimination, or toxic burden rather than acute changes

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Cardiovascular Calcification Risk: Higher hair Ca/Mg ratio is independently linked to increased coronary artery calcium scores, a marker of subclinical atherosclerosis. ***PMID 28168532*** · *Park B 2017*

Insulin Resistance Markers: Elevated hair Ca/Mg ratio correlates with higher triglyceride-glucose index (TyG) and triglyceride/HDL ratio, suggesting contribution to metabolic insulin resistance.

Fibromyalgia (mixed evidence): Some studies show higher hair Ca and Mg in fibromyalgia patients versus controls, though findings are inconsistent. ***PMID 10626702*** · *Ng SY 1999*

Slow Oxidation and Fatigue: High tissue Ca and Mg commonly accompany slow metabolic rate, chronic fatigue, reduced energy turnover, and protective adaptations to long-term stress.

Tissue Deposition and Calcification: Chronic bio-unavailability may promote soft-tissue calcification (arteries, joints), arterial stiffness, or degenerative changes when minerals precipitate rather than serve structural/enzymatic roles. ***PMID 28663256*** · *Ter Braake AD 2017*

JOHN SMITH

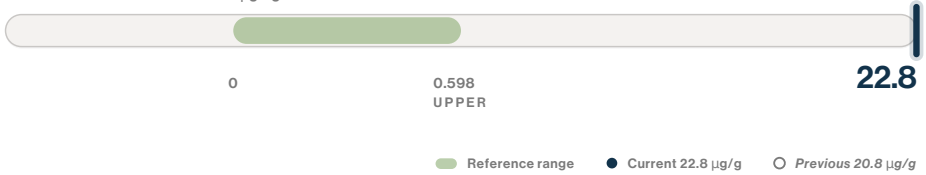
LEAD (Pb) **HIGH · OUT OF RANGE**

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Pb
Lead
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



SCAN FOR REFERENCED LITERATURE

Lead is a toxic metal with no known biological role in human physiology and a strong affinity for bone, giving it long-term biological persistence.

In hair mineral analysis, an elevated lead reading has been described as reflecting longer-term exposure patterns and the ongoing exchange between skeletal stores, soft tissues, and the growing hair shaft. Through competition with essential minerals such as calcium, iron, zinc, and magnesium, lead has been reported to disrupt enzyme activity, energy metabolism, antioxidant defences, and mineral regulation even when individual mineral values fall within reference ranges. Elevated hair lead is therefore read in the context of mineral interactions, skeletal storage dynamics, and the broader metabolic patterns reflected across the profile rather than as an isolated value.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & skeletal body burden	An elevated lead reading has been associated with longer-term exposure and an accumulated body burden, since lead is laid down in bone and exchanged slowly with soft tissues and the growing hair shaft. Research has linked this skeletal store to ongoing endogenous re-release during physiological stress, pregnancy, lactation, and bone turnover, so the hair value has been read against the calcium-storage minerals rather than as a single point. ***PMID 28811684***	Pb 22.8 (▲) · Ca 4,366 (▲) · Ca:Pb 192 (▼) · Ca:Mg 8.03 (·) · Sr 12.3 (▲) · Ca:Sr 355 (·)
Target-organ effects & heme/ erythropoiesis	Elevated lead has been associated with disruption of heme synthesis and erythropoiesis, with studies reporting that it inhibits the zinc-dependent enzyme delta-aminolevulinic acid dehydratase and interferes with iron incorporation into haemoglobin. Research has linked this pathway to lead's broader competition with iron and zinc, so the reading has been framed alongside those antagonists and the iron-utilisation indicators. ***PMID 22864587***	Pb 22.8 (▲) · Fe 23.4 (▲) · Zn 121 (▼) · Zn:Fe 5.17 (▼) · Fe:Cu 0.629 (·) · S 43,239 (·)
Protective & antagonist minerals	Studies suggested that adequate calcium, iron, and zinc status has been associated with reduced lead absorption, retention, and biological impact, with dietary calcium in particular linked to lower circulating lead during pregnancy and lactation. In hair-analysis practice the lead reading has therefore been weighed against the buffering minerals and their ratios rather than interpreted in isolation. ***PMID 17296490***	Pb 22.8 (▲) · Ca:Pb 192 (▼) · Ca 4,366 (▲) · Zn 121 (▼) · Zn:Pb 5.31 · Fe 23.4 (▲) · Mg 544 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Calcium reflects skeletal buffering capacity and the bone-related storage dynamics that govern how lead is retained and released.

Iron: shares absorption pathways with lead, influencing its tissue distribution and oxygen-handling; adequacy has been associated with reduced lead uptake.

Zinc: competes with lead at enzymatic binding sites and is often observed reduced where lead burden is present.

Magnesium: supports neuromuscular and energy-related stability affected by mineral displacement.

Sulphur: is relevant to lead's affinity for sulphur-based binding and elimination pathways.

ANTAGONISTS

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Studies using hair and blood biomarkers have reported associations between chronic lead exposure and reduced IQ, attention deficits, and developmental variability in children.

: Cohort and dose-response research has linked sustained lead exposure to elevated blood pressure, hypertension, and higher cardiovascular disease risk.

: Population cohorts have associated chronic lead burden with renal tubular dysfunction, proteinuria, and a higher risk of chronic kidney disease.

: Long-term exposure has been linked to reduced bone mineral density and increased fracture risk, through interference with calcium metabolism.

: Lead exposure has been associated with impaired heme synthesis, anemia, and altered oxygen transport through disrupted iron utilisation.

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Sb

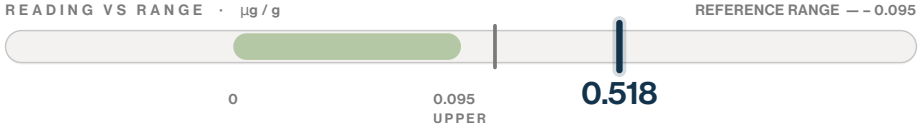
Antimony

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE — – 0.095



Reference range ● Current 0.518 µg/g ○ *Previous 0.118 µg/g*

SCAN FOR REFERENCED LITERATURE

Antimony is a metalloid with no known biological role, commonly encountered through industrial processes, manufactured materials, and certain consumer products.

In hair mineral analysis an elevated reading has been interpreted in terms of how this element has interacted with tissue-level mineral balance and elimination pathways over time rather than as a measure of total body burden. Antimony has been described as competing with minerals such as zinc, selenium, magnesium, and sulfur-containing compounds, which has been associated with added demand on the systems responsible for maintaining mineral balance and supporting natural elimination.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated antimony reading has been associated with cumulative environmental and occupational contact reported in the biomonitoring literature, where smelting, metal processing, solder and battery work, and flame-retardant materials such as antimony trioxide were described as exposure routes. It has been read holistically alongside the sulfur-handling and selenium pathways involved in metal binding and elimination rather than as a measure of total body burden. ***PMID 16307078***	Sb 0.518 (▲) · S 43,239 (·) · Se 0.461 (▼) · Zn 121 (▼) · Cu:Se 80.7 (▲)
Target-organ & cardiovascular strain	Higher antimony exposure has been linked in population studies with elevated blood pressure and increased hypertension risk, and occupational research has associated inhaled antimony with respiratory and oxidative-stress effects. The reading has been considered holistically against the calcium-magnesium buffering minerals and the sodium-to-potassium pacing relationship that frame vascular and adaptive tone. ***PMID 24945898***	Sb 0.518 (▲) · Na:K 3.17 (▲) · Ca:Mg 8.03 (·) · Mg 544 (▲) · Ca 4,366 (▲)
Protective & antagonist minerals	Studies of essential and toxic elements in the hair of occupationally exposed workers have described antimony in relation to the protective minerals that compete with it at binding sites and support antioxidant defense, notably selenium, zinc, and sulfur-containing compounds. The reading has been read holistically against these antagonists and the copper-selenium balance reflecting antioxidant reserve. ***PMID 30456579***	Sb 0.518 (▲) · Se 0.461 (▼) · Zn 121 (▼) · S 43,239 (·) · Cu:Se 80.7 (▲) · Zn:Cu 3.25 (▼)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Zinc: has been described as competing with antimony at enzyme and binding sites and as supporting antioxidant balance. Wilson L, Nutritional Balancing and Hair Mineral Analysis 1998

Selenium: has been described as relevant to neutralizing oxidative stress and supporting sulfur-related pathways involved in metal handling. Wilson L, Nutritional Balancing and Hair Mineral Analysis 1998

Sulfur-containing compounds: have been described as important for the binding and elimination pathways involved in handling metals such as antimony. Watts DL, Trace Elements and Other Essential Nutrients

Magnesium: has been described as supporting energy metabolism and neuromuscular stability that may be affected by mineral displacement. Wilson L, Nutritional Balancing and Hair Mineral Analysis 1998

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Population studies have observed associations between higher urinary antimony and elevated blood pressure or increased hypertension risk.

: Higher urinary antimony has been linked in population data to insufficient sleep, longer sleep latency, and possible obstructive sleep apnea symptoms.

: Occupational inhalation exposure has been associated with respiratory irritation, chronic bronchitis-like symptoms, and pneumoconiosis-like changes in exposed workers.

: Occupational studies have reported elevated oxidative stress and DNA damage biomarkers in antimony-exposed workers.

: Hair antimony levels have correlated strongly with urine (r = 0.870) and blood (r = 0.713) in occupational research, supporting hair mineral analysis for assessing longer-term exposure and related regulatory patterns.

CanAlt Health Laboratories

JOHN SMITH

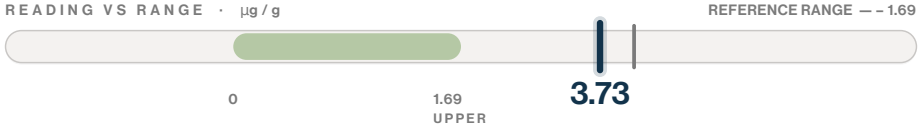
BARIUM (Ba) **HIGH · OUT OF RANGE**

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Ba
Barium
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



SCAN FOR REFERENCED LITERATURE

Barium is a non-essential alkaline-earth metal with no known biological role in human physiology, and elevated hair barium has been read in HMA as a marker of environmental or occupational exposure and the body's longer-term handling of that load rather than as total body burden.

The literature has described barium as competing with calcium, potassium, and magnesium — the minerals central to nerve conduction, muscle contraction, and cardiac rhythm — and as acting on potassium channels in ways that have been observed to influence cellular membrane potentials and metabolic pacing even when individual mineral values fell within reference ranges. Hair barium has been interpreted most meaningfully alongside the alkaline-earth group, electrolyte ratios, and other toxic elements, since barium may be incorporated into hair during periods of metabolic adjustment or mineral rebalancing.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated barium reading has been associated with sustained environmental, water-source, or occupational intake of this non-essential alkaline-earth metal, with biomonitoring studies treating hair and tissue barium as a marker of longer-term handling of that load rather than total body burden. It has been read holistically alongside the alkaline-earth group and co-occurring toxic metals, since the regulatory and oxidative demand of a mixed metal load has been described as shared across elimination pathways. ***PMID 36402181***	Ba 3.73 (▲) · Sr 12.3 (▲) · Ca:Sr 355 (·) · Ca:Pb 192 (▼) · Ca:Cd 545,750 (·) · Pb 22.8 (▲)
Cardiac & neuromuscular targets	Because soluble barium has been observed to act on potassium channels and drive potassium into cells, an elevated reading has been linked in case and occupational series with hypokalemia, flaccid muscle weakness, and cardiac arrhythmias. It has been read holistically against potassium and the electrolyte ratios, which frame the membrane-potential and metabolic-pacing strain barium has been described as imposing. ***PMID 40729295***	Ba 3.73 (▲) · K 517 (▲) · Na:K 3.17 (▲) · Mg 544 (▲) · Ca 4,366 (▲) · Ca:Mg 8.03 (·)
Protective & antagonist minerals	In hair-analysis practice barium has been read against the minerals it competes with, where calcium and magnesium have been described as buffering the alkaline-earth load through the Ca:Sr and Ca:Mg relationships and where sulfur-based pathways have been noted to participate in endogenous binding and elimination. Adequate potassium and these antagonist minerals have been interpreted holistically as the framework against which tolerance to barium is gauged. ***Watts DL, Trace Elements Inc. — HTMA alkaline-earth antagonist and buffering convention***	Ca 4,366 (▲) · Mg 544 (▲) · Ca:Mg 8.03 (·) · Ca:Sr 355 (·) · S 43,239 (·) · K 517 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Calcium: has been described as competing with barium in neuromuscular signalling and tissue distribution, with the Ca:Ba relationship reflecting buffering against the alkaline-earth load.

Magnesium: has been noted to support neuromuscular stability and energy metabolism under electrolyte stress where barium interferes with calcium- and potassium-dependent processes.

Potassium status: has been read alongside barium because barium has been observed to act on potassium channels and alter cellular electrical activity.

Sulfur-based pathways: have been described as participating in the endogenous binding and elimination of barium and other metals.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Acute or high-level exposure to soluble barium has been associated with cardiac arrhythmias, blood pressure changes, and ECG abnormalities in case reports and occupational-exposure series.

: High-level barium exposure has been linked to muscle weakness, paresthesia, and flaccid paralysis, frequently described alongside hypokalemia in documented cases.

: Ingestion of soluble barium compounds has been associated with severe vomiting, abdominal pain, diarrhea, and gastrointestinal irritation in acute exposure incidents.

: Case reports of significant barium exposure have noted acute kidney injury or renal insufficiency in severe intoxication scenarios.

CanAlt Health Laboratories

JOHN SMITH

NICKEL (Ni) HIGH · OUT OF RANGE

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Ni

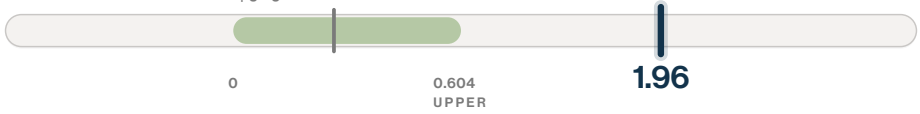
Nickel

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE — – 0.604



Reference range ● Current 1.96 µg/g ○ *Previous 0.267 µg/g*

SCAN FOR REFERENCED LITERATURE

Nickel is a widely distributed trace metal with no established essential biological role in human physiology, and an elevated hair reading has been described as reflecting longer-term exposure and gradual tissue accumulation rather than recent intake.

In hair mineral analysis, a high nickel reading has been read as the ongoing exchange between environmental and dietary intake, tissue stores, and the growing hair shaft, with nickel reported to compete with essential elements at shared absorption, transport, and enzymatic binding sites. Nickel is interpreted alongside its mineral relationships and the broader metabolic pattern rather than as an isolated value, since stored nickel may be mobilised and reflected in hair during periods of metabolic adjustment or mineral rebalancing.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated nickel reading has been associated with longer-term environmental, dietary, or occupational exposure and gradual tissue accumulation rather than recent intake, with research linking sustained nickel contact to allergic contact dermatitis and skin reactivity in exposed individuals. It is read holistically against co-retained toxic metals and the sulfur-dependent handling pathways rather than as an isolated value. ***PMID 31524759***	Ni 1.96 (▲) · Pb 22.8 (▲) · Cd 0.008 (·) · Al 11.1 (·) · S 43,239 (·) · Ca:Pb 192 (▼) · Ca:Cd 545,750 (·)
Target-organ effects	A high nickel burden has been associated with cardiovascular strain in population studies and with renal tubular changes in exposed cohorts, where research has linked sustained nickel to endothelial dysfunction, elevated blood pressure, and proteinuria-type kidney patterns. The reading is framed alongside calcium, magnesium, and the fluid-balance and neuromuscular ratios rather than read in isolation. ***PMID 37360515***	Ni 1.96 (▲) · Ca 4,366 (▲) · Mg 544 (▲) · Ca:Mg 8.03 (·) · Na:K 3.17 (▲) · K 517 (▲)
Protective & antagonist minerals	In hair-analysis practice an elevated nickel reading has been read against the minerals reported to compete with it at shared absorption, transport, and enzymatic binding sites, with zinc and iron described as antagonists and sulfur-bearing compounds framing thiol-based binding and elimination. The pattern is interpreted as the balance between nickel and these protective minerals rather than nickel alone. ***Watts DL, Trace Elements Inc. — nickel mineral antagonism (Zn / Fe / S) in HTMA***	Ni 1.96 (▲) · Zn 121 (▼) · Fe 23.4 (▲) · S 43,239 (·) · Zn:Cu 3.25 (▼) · Fe:Cu 0.629 (·) · S:Cu 1,163 (▼)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Zinc: has been described as competing with nickel at enzymatic binding sites and supporting antioxidant enzyme activity.

Iron: shares absorption and transport pathways with nickel and has been reported to influence its tissue distribution and metabolic efficiency.

Magnesium: has been described as supporting the enzymatic and neuromuscular stability that may be affected by nickel displacement.

Sulfur-containing compounds: have been reported as relevant to nickel binding and endogenous handling through gastrointestinal and biliary elimination routes.

ANTAGONISTS

Hydrogenated oils processed with nickel catalysts, canned foods, and stainless steel cookware and utensils have been described as dietary and consumer contributors to nickel exposure.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Chronic nickel exposure has been strongly associated with allergic contact dermatitis, skin reactivity, and hand eczema in occupationally and environmentally exposed individuals.

: Sustained inhalation exposure has been linked to respiratory irritation, lung fibrosis, and chronic bronchitis-like symptoms in occupational cohorts.

: Chronic nickel burden has been associated with endothelial dysfunction, elevated blood pressure, and potential cardiovascular disease risk in population and occupational studies.

: Long-term exposure has been linked to renal tubular dysfunction, proteinuria, and kidney disease patterns in exposed workers and general populations.

: Occupational exposure to certain nickel compounds has been associated with increased risk of lung and nasal cancers in refinery and processing cohorts.

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

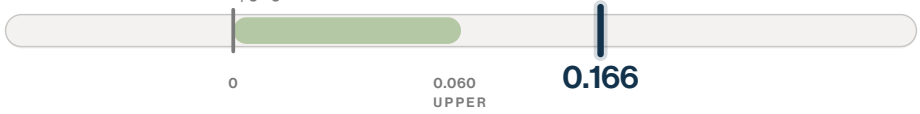
Bi

Bismuth

Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



Reference range ● Current 0.166 µg/g ○ *Previous 0 µg/g*

SCAN FOR REFERENCED LITERATURE

Bismuth is a nonessential element, and elevated hair levels have most commonly been reported to reflect external contact or use of bismuth-containing products rather than dietary intake.

In the mineral-balancing literature an elevated reading has been described as an indicator of how the body has been handling this element under current metabolic conditions, shaped by sulfur-dependent binding capacity, clearance efficiency, and the pace of mineral-driven tissue turnover. Because many bismuth compounds have shown limited absorption and low long-term tissue retention, the reading has been read most meaningfully alongside mineral dependencies, overall toxic-metal load, and the broader metabolic pattern across the profile rather than as an isolated value.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated bismuth reading has been most commonly associated with topical, cosmetic, or medicinal bismuth contact (oxychloride pigments, antacids, gastrointestinal remedies) rather than dietary intake, and case reports have linked product use to harmless markers such as black tongue. It has been read holistically as exposure or mobilization against the Bi:S ratio and overall toxic-metal load rather than as accumulation in isolation. ***PMID 20027942***	Bi 0.166 (▲) · Bi:S 0.000 · S 43,239 (·) · Se 0.461 (▼) · Zn 121 (▼)
Target-organ effects	When bismuth has been absorbed systemically, case reports have associated higher body burden with reversible renal injury, since the kidney is described as the main elimination route, and case series have linked prolonged exposure to a reversible encephalopathy. The reading has been framed against selenium and zinc reserves that buffer metal-related oxidative demand. ***PMID 11961412***	Bi 0.166 (▲) · Se 0.461 (▼) · Zn 121 (▼) · S 43,239 (·) · Bi:Se 0.360
Protective & antagonist minerals	Bismuth has been shown to bind thiol (sulfur-containing) groups on proteins, and lower selenium and zinc have been reported to reduce the adaptive capacity that buffers metal-related oxidative demand and competes at metal-binding sites. The reading has been interpreted against the Bi:S and Bi:Se ratios and sulfur-dependent biochemistry rather than the bismuth value alone. ***PMID 8395060***	Bi:S 0.000 · Bi:Se 0.360 · Se 0.461 (▼) · Zn 121 (▼) · S 43,239 (·) · Bi 0.166 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Selenium: has supported antioxidant defense and the buffering of metal-related oxidative demand; lower selenium has been reported to reduce adaptive capacity when bismuth is elevated.

Zinc: competes at metal-binding sites and supports enzymatic and neurological regulation; lower zinc has been observed to coincide with reduced tolerance to metal-related stress.

Sulfur: is central to thiol-based binding and transport pathways; sulfur-dependent biochemistry has been described as strongly influencing how bismuth is handled and eliminated.

ANTAGONISTS

Hair bismuth: has been reported to decline after cosmetic, medicinal, or environmental sources are removed, reflecting limited long-term tissue retention.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Bismuth-containing medications have been associated with harmless black stools or black tongue arising from bismuth sulfide formation, and overuse has been linked in case reports to nausea, vomiting, abdominal pain, or transient digestive slowing.

: Prolonged or high-level bismuth exposure has been associated in case series with a reversible encephalopathy described as progressive confusion, myoclonus, ataxia, gait instability, dysarthria, tremor, lethargy, or hallucinations, with recovery reported over weeks to months after exposure stopped.

: Because the kidneys have been described as the main elimination route, overdose or impaired clearance has been associated in reports with dose-dependent, usually reversible acute kidney injury, including azotemia, oliguria, proteinuria, tubular necrosis, or Fanconi-type changes.

: Bismuth has been shown to bind thiol (sulfur-containing) groups on proteins, a biochemical mechanism reported to alter enzyme activity and increase oxidative demand under systemic overload.

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SCAN FOR REFERENCES

Protective Ratios

Hair mineral analysis provides a tissue-level snapshot of mineral balance and the elimination of toxic metals such as mercury, lead, cadmium, and arsenic. These toxic elements often appear elevated in hair exactly when the body is actively mobilizing and excreting them. The resulting pattern offers insight into metabolic activity and current detoxification capacity.

MINERAL-TO-TOXIC-METAL RATIOS

HIGHER = STRONGER PROTECTIVE BUFFER

Ca:Cd **545,750**	Fe:Pb **1.0**	Zn:Hg **205.4**	Se:Hg **0.78**
Se:As **30.7**	Fe:Hg **39.8**	Ca:Pb **191.7**	Zn:Cd **15,100**

WHY RATIOS MATTER

Ratios between protective nutrient minerals and toxic metals (e.g., Ca/Pb, Se/As, Zn/Cd, Fe/Pb) are usually more clinically meaningful than absolute levels alone. These ratios reflect how well essential minerals compete at absorption sites, induce metallothionein proteins that sequester toxins, and maintain glutathione-dependent antioxidant pathways.

A favorable ratio suggests effective elimination; an unfavorable ratio suggests mineral depletion, reduced binding capacity, or greater retention of toxins in deeper tissues.

INTERPRETING RESULTS

Mineral levels and ratios should never be read in isolation; they belong in the context of the complete mineral pattern. Low nutrient-mineral values may indicate depleted reserves or a reduced metabolic rate after chronic stress, both of which limit detoxification efficiency and allow toxic metals to remain stored in organs and tissues.

Conversely, very low toxic-metal readings do not always mean low exposure. They can reflect poor mobilization and ongoing internal storage. Serial hair analyses over months or years usually provide the most reliable view of progress: as mineral balance improves and metabolic activity rises, previously stored toxins are often released, temporarily raising hair toxic-metal levels during elimination.

KEY PROTECTIVE MINERALS

Zinc: Induces metallothionein proteins that bind cadmium and mercury and promote their elimination. Also supports immune function and tissue repair.

Selenium: Strengthens cellular antioxidant defenses and works with glutathione to neutralize oxidative stress when stored toxins are mobilized.

Calcium: Serves as a marker of metabolic state. Persistently elevated hair calcium often reflects soft-tissue deposition that can slow detoxification.

Iron: Competes with lead and cadmium at the DMT1 transporter. Adequate iron limits absorption; deficiency increases it. Excess iron should be avoided due to Fenton-reaction oxidative stress.

Sulfur: Sulfur-containing amino acids from dietary protein drive glutathione synthesis and metallothionein function. Cruciferous vegetables, garlic, onions, and quality protein support this pathway.

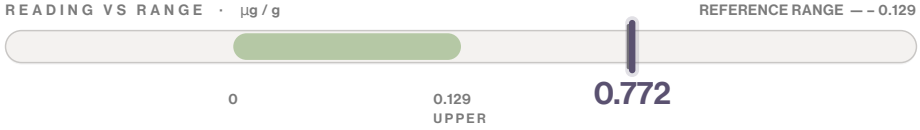
The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Ag
Silver
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g

REFERENCE RANGE — – 0.129



Reference range · Current 0.772 µg/g · *Previous 0.718 µg/g*

SCAN FOR REFERENCED LITERATURE

Silver is a nonessential metal with no known physiological requirement, and excess tissue accumulation has been reported to interfere with normal biochemical processes.

The experimental and observational literature has described silver as a broad enzyme inhibitor with affinity for sulfur-containing proteins, and elevated levels have been associated with disruption of antioxidant activity, cellular respiration, and membrane stability. In hair mineral analysis, an elevated silver reading has been described as reflecting longer-term tissue incorporation rather than acute exposure, offering insight into sustained presence and the body's handling of the metal.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated silver reading has been associated with cumulative exposure and tissue incorporation from sources such as colloidal silver, occupational dust, dental and wound-care products, and jewellery rather than with acute contact. In hair-analysis practice it has been read holistically as a long-term body-burden marker, framed against the oxidation-rate pattern and the major minerals to distinguish sustained retention from temporary mobilisation. ***PMID 15964881***	Oxidizer Type: Slow/Extreme Slow · Ag 0.772 (▲) · Ca 4,366 (▲) · Mg 544 (▲) · Na 1,638 (▲) · K 517 (▲)
Target-organ deposition	Chronic silver accumulation has been associated with deposition in skin, mucous membranes, and the eye, where the literature has described argyria and ocular argyrosis as the most commonly reported and largely cosmetic effects of sustained exposure. The reading has been interpreted holistically alongside total burden and the structural minerals that frame the tissue-retention pattern. ***PMID 32591303***	Ag 0.772 (▲) · Ca 4,366 (▲) · S 43,239 (·) · Se 0.461 (▼) · Zn 121 (▼)
Protective & antagonist minerals	Elevated silver has been associated with interference at selenium- and copper-dependent antioxidant enzyme systems such as glutathione peroxidase and superoxide dismutase, and with competition for zinc at sulfur-rich metallothionein binding sites. Research has linked these antagonist relationships to disrupted oxidative balance, so the reading has been framed holistically against selenium, copper, and zinc status. ***PMID 30046482***	Hg:Se · Ag 0.772 (▲) · Se 0.461 (▼) · Cu 37.2 (▲) · Zn 121 (▼) · Cu:Zn 0.308 · S 43,239 (·)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Selenium: has been reported to support glutathione peroxidase activity and antioxidant capacity within systems where silver has been described as an inhibitor.

Copper-dependent enzyme systems, including superoxide dismutase, have been described in the literature as participating in the oxidative balance with which silver interacts.

Sulfur-containing amino acids such as cysteine have been described as the protein binding context relevant to silver's affinity and to conjugation and elimination pathways.

ANTAGONISTS

Silver: has been reported to interfere with copper- and selenium-dependent antioxidant enzymes (superoxide dismutase, glutathione peroxidase), a pattern associated with disrupted oxidative balance and reduced cellular defense.

Silver: has been reported to compete with zinc for metallothionein binding sites, a pattern associated with altered zinc distribution and metal-sequestration capacity.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Chronic silver exposure has been associated with argyria, a permanent blue-gray discoloration of the skin and mucous membranes that has been described as irreversible and mainly cosmetic, and as the most commonly reported effect of sustained exposure.

: Silver exposure from occupational dust or colloidal silver ingestion has been associated with ocular argyrosis, a gray-blue pigmentation of the cornea, conjunctiva, and sclera that has typically been reported without major vision impairment.

: Inhalation of silver dust or compounds in higher occupational exposures has been associated with upper airway, throat, and lung irritation, with breathing difficulty reported in some settings.

: Silver ions and nanoparticles have been reported to generate reactive oxygen species and to inhibit antioxidant enzymes such as superoxide dismutase and glutathione peroxidase, a pattern that has been linked with cellular damage and inflammation in experimental models.

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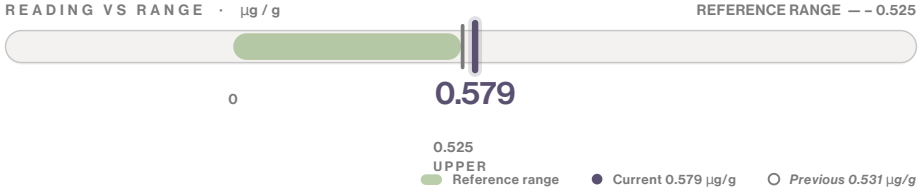
TIN (Sn) HIGH · OUT OF RANGE

The information on this page is provided to support the practitioner's independent clinical assessment, drawn from the published mineral balancing literature, alongside clinical history, physical assessment, and confirmatory testing where clinically appropriate.

Sn
Tin
Above range

HAIR MINERAL ANALYSIS · ELEMENT REFERENCE

READING VS RANGE · µg / g



SCAN FOR REFERENCED LITERATURE

Tin is a naturally occurring metal with no clearly established essential role in human physiology; in hair mineral analysis its relevance has been described as that of an environmental and industrial metal that can accumulate in tissue under conditions of repeated exposure or reduced elimination efficiency.

The mineral-balancing literature has read an elevated tin alongside zinc, iron, copper, and selenium, since tin has been reported to interact with these minerals in enzymatic activity and cellular energy processes. An elevated reading has been interpreted in the broader context of oxidation rate and antioxidant capacity rather than as an absolute value, and is read to distinguish active exposure from reduced clearance or the mobilisation of stored metal during mineral rebalancing.

SCENARIO REFERENCE

Scenarios described in the published mineral-balancing literature. These are descriptions of the taxonomy, not characterizations of the patient.

RELATES TO	LITERATURE DESCRIPTION	RELATED READINGS
Exposure & body burden	An elevated tin reading has been associated with environmental or dietary exposure to inorganic tin and with reduced elimination efficiency rather than with any established physiological need, since tin has no clearly essential role in humans. In hair-analysis practice it has been read within the wider toxic-metal pattern to distinguish an isolated exposure from a broader body burden, and against oxidation rate to gauge active uptake versus mobilisation of stored metal during rebalancing. ***Watts DL, Trace Elements Inc. — HTMA toxic-metal body-burden pattern***	Sn 0.579 (▲) · Pb 22.8 (▲) · Cd 0.008 (·) · Al 11.1 (·) · Hg 0.588 (·) · As 0.015 (·)
Target-organ effects	Elevated tin has been associated with gastrointestinal irritation following ingestion of inorganic tin from contaminated or unlacquered canned foods, and chronic high intake has been linked in animal models with reduced iron status, lower haemoglobin and haematocrit. The reading has therefore been cross-referenced with iron and the haematological minerals to frame whether a target-organ effect is plausible alongside the exposure. ***PMID 14563391***	Sn 0.579 (▲) · Fe 23.4 (▲) · Cu 37.2 (▲) · Fe:Cu 0.629 (·) · Ca:Fe 187 (▲) · Mn 0.237 (·)
Protective & antagonist minerals	An elevated tin has been read holistically against zinc, selenium, and iron, since dietary tin has been reported to inhibit zinc retention at the intestinal level and reduced antioxidant and mineral status has been associated with a greater tendency to retain tin. Adequate zinc and selenium have been described as protective considerations, so the reading has been framed by the Zn:Cu balance and the zinc-to-lead relationship rather than by tin alone. ***PMID 6837491***	Zn:Pb · Sn 0.579 (▲) · Zn 121 (▼) · Se 0.461 (▼) · Zn:Cu 3.25 (▼) · Cu:Se 80.7 (▲)

☐ IDENTIFIED ☐ BORDERLINE ☐ NOT IDENTIFIED

NUTRITIONAL COFACTOR NOTES

SYNERGISTS

Zinc: has been reported to compete with tin at absorption and enzyme-regulation sites; adequate zinc status has been associated with a reduced tendency to retain tin.

Selenium: supports antioxidant buffering capacity, which the literature has linked to the body's handling of retained tin.

Iron status: has been read alongside tin because chronic inorganic tin exposure has been reported to interfere with iron metabolism, and adequate iron has been described as a consideration where tin is retained.

Oxidation-rate and antioxidant-capacity context: has been used to read whether an elevated tin reflects active exposure or reduced elimination.

LITERATURE OBSERVATIONS

PEER-REVIEWED

: Acute ingestion of inorganic tin from contaminated canned foods, often from unlacquered cans, has been associated with gastrointestinal irritation including nausea, vomiting, abdominal pain, cramping, and diarrhoea, described as gastric irritation at high doses.

: High dietary tin has been reported to impair zinc absorption and retention, increasing faecal zinc excretion, decreasing plasma zinc, and potentially producing negative zinc balance, a pattern described as disrupting zinc-dependent enzymes.

Neurodevelopmental indicators: Elevated hair tin has been reported alongside other toxic metals in children with autism spectrum disorder, where it has been described as a potential marker of broader environmental burden; the links have been characterised as associative and not causal for tin alone. *Hair multi-element autism-spectrum biomonitoring research*

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CA/P RATIO · HIGH

Information on this page is provided for educational and reference purposes only — drawn from the published mineral balancing literature — and should not be relied upon as the basis for clinical diagnosis or treatment decisions.

SCAN FOR REFERENCES

Ca/P

Calcium · Phosphorus

▲ HIGH

HAIR MINERAL ANALYSIS · RATIO REFERENCE

32.9

REFERENCE RANGE
1.60–3.99

MULTIPLE OF UPPER
8.2×

READING COMPONENTS
Ca 4366 · P 132.9

NORMAL BAND 1.60–3.99

0

32.9
CURRENT

The calcium phosphorus (Ca/P) ratio assesses autonomic nervous system balance and metabolic type.

This pattern often arises in prolonged or chronic stress, where the body shifts toward rest-and-digest mode to preserve resources after sympathetic exhaustion. Physiologically, high calcium relative to phosphorus reduces cellular excitability and protein breakdown, supporting tissue maintenance but limiting rapid energy output. Over time, it reflects slow oxidation, reduced vitality, and trends toward metabolic conservation with potential for sluggish digestion and lower stamina.

Balancing an elevated Ca/P ratio focuses on gently supporting phosphorus-linked activation to restore autonomic flexibility. This involves phosphorus-appropriate nutrient dense foods (for example, quality proteins and vegetables), addressing chronic stress, and targeted protocols. Normalization promotes balanced energy, improved responsiveness, and a shift from heavy parasympathetic buffering to efficient metabolic flow.

CLINICAL ASSOCIATIONS — LITERATURE REVIEW

Parasympathetic Dominance: Elevated calcium relative to phosphorus reflects parasympathetic dominance, often presenting as slower reactivity, emotional withdrawal, or reduced drive in chronic adaptation phases.

Slow Metabolic Type: Consistent with slow oxidation, where anabolic processes predominate, leading to lower energy production and trends toward fatigue or sluggish metabolism.

Reduced Protein Catabolism: High calcium limits phosphorus-driven breakdown, associated with tissue preservation but potential for poor protein utilization or stagnation.

Parathyroid/Thyroid Influence: Linked to relative parathyroid dominance or thyroid suppression at tissue level, contributing to calcium retention and metabolic slowing. ***PMID 37854194*** · *De Vincentis S 2023*

Bone and Mineralization Trends: Calcium predominance supports structural stability but may relate to calcification risks or altered bone remodeling in long-term imbalance.

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CA/ZN RATIO · HIGH

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SCAN FOR REFERENCES

Ca/Zn

Calcium · Zinc

▲ HIGH

HAIR MINERAL ANALYSIS · RATIO REFERENCE

36.1

REFERENCE RANGE
1.62–7.54

MULTIPLE OF UPPER
4.8×

READING COMPONENTS
Ca 4366 · Zn 120.8

NORMAL BAND 1.62–7.54

0

36.1
CURRENT

The calcium zinc (Ca/Zn) ratio evaluates immune balance, inflammatory regulation, and metabolic efficiency.

This pattern often emerges in chronic stress, zinc depletion from poor diet or malabsorption, or excess calcium intake. Physiologically, high calcium relative to zinc impairs zinc-dependent enzymes (such as superoxide dismutase and alkaline phosphatase), reduces immune competence, and promotes pro-inflammatory states. Over time, it reflects trends toward immune weakness, chronic inflammation, hormonal imbalance (low testosterone, thyroid suppression), and metabolic slowing with fatigue and poor wound healing.

Balancing an elevated Ca/Zn ratio focuses on supporting zinc status to restore immune and enzymatic function. This involves zinc-rich nutrient dense foods (for example, pumpkin seeds, oysters, or beef in moderation), reducing excess calcium sources, and targeted protocols. Normalization promotes stronger immune regulation, reduced inflammation, and a shift from sluggish metabolism to efficient cellular activity.

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Immune Suppression: High calcium relative to zinc correlates with reduced immune competence, increased susceptibility to infections, and delayed wound healing; associated with zinc deficiency states seen in recurrent infections and poor recovery. ***PMID 9701160*** · *Shankar AH 1998*

Chronic Inflammation and Autoimmune Tendencies: Zinc insufficiency promotes pro-inflammatory cytokine elevation (IL-6, TNF-), linked to chronic inflammatory conditions and autoimmune risk in observational studies. ***PMID 25656040*** · *Wong CP 2015*

Hormonal Imbalance: Calcium dominance relative to zinc is associated with hypogonadism (low testosterone), hypothyroidism trends, and growth hormone suppression; common in zinc-deficient metabolic states. ***PMID 8875519*** · *Prasad AS 1996*

Metabolic Syndrome and Insulin Resistance: Higher Ca/Zn ratios in hair are linked to metabolic syndrome components, including insulin resistance and inflammation in population studies. ***PMID 24671621*** · *Choi WS 2014*

Bone and Tissue Integrity: High calcium with low zinc may impair bone remodeling enzymes, contributing to osteoporosis risk or poor connective tissue health in chronic depletion patterns. ***PMID 20535396*** · *Cho YE 2007*

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ZN/CU RATIO · LOW

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SCAN FOR REFERENCES

Zn/Cu

Zinc · Copper

▼ LOW

HAIR MINERAL ANALYSIS · RATIO REFERENCE

3.2

REFERENCE RANGE	MULTIPLE OF UPPER	READING COMPONENTS
4.92–25.6	—	Zn 120.8 · Cu 37.18

NORMAL BAND 4.92–25.6

The zinc copper (Zn/Cu) ratio is a critical marker in hair mineral analysis for immune modulation, hormonal balance, and thyroid function.

This pattern frequently develops in chronic stress, copper overload (for example, from water pipes or IUDs), or zinc deficiency from diet malabsorption. Physiologically, high copper relative to zinc disrupts zinc dependent enzymes, promotes pro inflammatory cytokines, and leads to estrogen dominance. Serum levels may show transient low Zn or high Cu/Zn during acute inflammation, but hair levels extend these observations by revealing chronic copper dominance, commonly interpreted in HMA as hidden (biounavailable) copper toxicity, where copper accumulates in tissues (liver, brain, thyroid) despite normal or low normal serum copper. Over time, it reflects trends toward chronic inflammation, immune weakness, hypothyroidism, and risks of metabolic syndrome or cancer.

Balancing a reduced Zn/Cu ratio emphasizes supporting zinc status to restore enzymatic and hormonal function. This involves zinc rich nutrient dense foods (for example, pumpkin seeds or beef in moderation), reducing copper sources, and targeted protocols. Normalization promotes stronger immune competence, reduced inflammation, and a shift from sluggish metabolism to efficient cellular activity.

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Immune Suppression: Low zinc relative to copper correlates with reduced immune competence, increased infection susceptibility, and delayed wound healing; associated with zinc deficiency in recurrent infections or ADHD in children. ***PMID 2200472*** · *Keen CL 1990*

Chronic Inflammation: Copper predominance promotes pro inflammatory cytokine elevation (IL 6, TNF), linked to chronic conditions like rheumatoid arthritis or metabolic syndrome. ***PMID 21223959*** · *Guo CH 2011*

Thyroid Disorders: Reduced Zn/Cu is strongly associated with hypothyroidism and Hashimoto's thyroiditis, as copper excess and zinc deficiency impair thyroid hormone synthesis, T3/T4 conversion, and TSH signaling. Hair levels extend serum findings by confirming chronic imbalance, often interpreted as hidden copper toxicity, in persistent thyroid autoimmunity. ***PMID 8157857*** · *Nishiyama S 1994*

Metabolic Syndrome and Insulin Resistance: Lower Zn/Cu ratios in hair are linked to metabolic syndrome components, including insulin resistance and obesity in population studies. ***PMID 32545948*** · *Jeong SY 2021*

Hormonal Imbalance: Reduced Zn/Cu is associated with estrogen dominance, hypothyroidism trends, and reduced testosterone; common in androgenetic alopecia and PCOS like states, especially when hidden copper toxicity is present.

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CA/FE RATIO · HIGH

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SCAN FOR REFERENCES

Ca/Fe

Calcium · Iron

▲ HIGH

HAIR MINERAL ANALYSIS · RATIO REFERENCE

186.7

REFERENCE RANGE
17.1–82.7

MULTIPLE OF UPPER
2.3×

READING COMPONENTS
Ca 4366 · Fe 23.38

NORMAL BAND 17.1–82.7

The calcium iron (Ca/Fe) ratio reflects the balance between calcium, a primary structural and buffering mineral, and iron, a core carrier of oxygen and driver of cellular energy production.

Physiologically, a high Ca/Fe ratio may reflect functional iron underutilization, where tissue iron stores are present but poorly mobilized due to competing calcium deposition, inflammation-related sequestration, or suppressed cellular metabolic demand. Calcium excess can interfere with iron absorption at the gut and with iron handling at the cellular level through shared transport pathways. Over time, the imbalance is associated with reduced aerobic capacity, slower recovery after exertion, cold intolerance, and trends toward fatigue that do not fully respond to iron supplementation alone.

Balancing an elevated Ca/Fe ratio focuses on improving functional iron availability while gently moderating excess calcium retention. Strategies include iron-supportive nutrient-dense foods (for example, well-sourced red meat, organ meats, and vitamin-C-rich vegetables), separating calcium-heavy foods and supplements from iron-rich meals, and addressing underlying inflammation or digestive factors that reduce iron mobilization. As the ratio normalizes, improvements are typically seen in energy production, exercise tolerance, thermoregulation, and overall metabolic pace.

CLINICAL ASSOCIATIONS

LITERATURE REVIEW

Reduced Oxidative Capacity: Elevated calcium relative to iron is associated with lower tissue oxygen utilization, reduced aerobic capacity, and trends toward fatigue that persist despite adequate serum iron levels.

Functional Iron Underutilization: High Ca/Fe patterns often reflect anemia of chronic disease or inflammation-mediated iron sequestration, where total-body iron may be adequate but cellular iron availability is reduced.

Slow Metabolic Rate: Consistent with slow oxidation in mineral balancing frameworks — limited iron-driven mitochondrial activity contributes to lower basal metabolic output, cold intolerance, and sluggish recovery.

Calcium Deposition Risk: Excess calcium unbalanced by iron-dependent catabolic processes may increase the risk of soft-tissue calcification, including in arterial walls and connective tissue.

Altered Absorption Dynamics: Elevated dietary or supplemental calcium is well-documented to inhibit non-heme iron absorption, potentially contributing to persistent tissue-level iron insufficiency despite reasonable dietary intake.

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MG/P RATIO · LOW

Information on this page is provided for educational and reference purposes only — drawn from the published mineral balancing literature — and should not be relied upon as the basis for clinical diagnosis or treatment decisions.

SCAN FOR REFERENCES

Mg/P

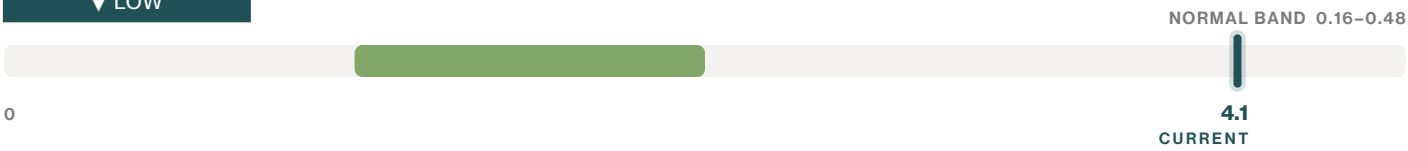
Magnesium · Phosphorus

▼ LOW

HAIR MINERAL ANALYSIS · RATIO REFERENCE

4.1

REFERENCE RANGE	MULTIPLE OF UPPER	READING COMPONENTS
0.16–0.48	8.5×	Mg 543.6 · P 132.9



In hair mineral analysis (HMA), the magnesium-to-phosphorus (Mg/P) ratio serves as one of the most telling indicators of metabolic rate, carbohydrate handling, and autonomic nervous system balance.

A high Mg/P ratio often points to slower oxidation patterns—lower metabolic rate, parasympathetic dominance, reduced energy turnover, and a tendency toward carbohydrate sensitivity or poor sugar tolerance. People with this pattern frequently report fatigue, sluggishness, cold hands/feet, or difficulty mobilizing energy quickly.

A low Mg/P ratio, by contrast, commonly reflects fast oxidation—sympathetic overdrive, accelerated metabolism, and a more "high-strung" state. This can manifest as irritability, anxiety, rapid heartbeat, blood sugar swings, or a sense of burning through energy too quickly without adequate recovery.

Because magnesium and phosphorus pull in opposite directions (relaxation vs. activation), the Mg/P ratio gives a clear snapshot of whether the body leans toward rest-and-digest or fight-or-flight dominance at the metabolic level. Like every HMA ratio, its interpretation is strongest when considered within the full mineral pattern, symptoms, and lifestyle context rather than viewed in isolation.

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CU/SE RATIO · LOW

Information on this page is provided for educational and reference purposes only — drawn from the published mineral balancing literature — and should not be relied upon as the basis for clinical diagnosis or treatment decisions.

SCAN FOR REFERENCES

Cu/Se

Copper · Selenium

▼ LOW

HAIR MINERAL ANALYSIS · RATIO REFERENCE

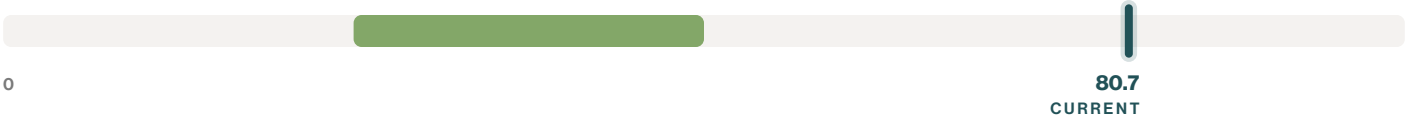
80.7

REFERENCE RANGE
10.4–27.8

MULTIPLE OF UPPER
2.9×

READING COMPONENTS
Cu 37.18 · Se 0.461

NORMAL BAND 10.4–27.8



Hair mineral analysis (HMA) uses the copper-to-selenium (Cu/Se) ratio to capture how well the body balances copper load against its protective antioxidant and thyroid-support mechanisms.

When the Cu/Se ratio climbs high, selenium is often outmatched by copper. This setup shows up frequently in slow-oxidation profiles, where metabolism runs cooler, energy feels heavy, and tissues tend to hold onto minerals. The fallout can include creeping oxidative stress, sluggish thyroid conversion, subtle hormonal shifts, brain fog, or a general sense of being "wired but tired." Copper's unchecked influence starts to tip the scales toward irritation and fatigue rather than smooth function.

A more favorable (lower) Cu/Se ratio, by contrast, usually means selenium is holding its ground: copper stays in check, oxidative pressure eases, thyroid signaling flows better, and the whole system breathes a little easier.

In short, this ratio quietly reveals whether antioxidant defenses and thyroid conversion are keeping pace with copper demands. Like every HMA marker, its real story emerges only when you zoom out and look at the full mineral landscape alongside the person's symptoms and history.

RATIOS

HIGH Ca/K RATIO

READING	REFERENCE RANGE
8.5	0.59–5.57

Points to **thyroid sluggishness** â€" calcium banks in tissue while potassium drops, a signature of reduced cellular energy and slowed oxidation. The **earliest HMA marker for subclinical hypothyroidism**, often preceding TSH drift into a treatable range by months. A **full thyroid panel (TSH, fT3, fT4, reverse T3)** is warranted when paired with cold intolerance, slow morning metabolism, or weight gain resistant to dietary change. Supports â€" iodine if deficient, selenium, zinc, tyrosine precursors â€" should be guided by lab values rather than the hair finding alone.

HIGH Na/K RATIO

READING	REFERENCE RANGE
3.2	0.86–2.71

Sympathetic-dominant 'wired and tired' zone â€" activation is maintained but not peaking. Mid-night waking with a racing mind in an exhausted body is the classic presentation. A **rising trend** across consecutive tests is more meaningful than a single value, because stress-axis activation compounds over time. **Na/Mg** confirms whether adrenal output is still active or the pattern is residual from a prior cycle. Responds to foundational support â€" magnesium, B-complex, targeted adaptogens, and consistent meal timing â€" before the pattern transitions downward.

Fe/Mn RATIO

READING	REFERENCE RANGE
98.6	15.3–77.0

Absorption-level competition â€" iron and manganese compete for the same transporter (DMT1). One typically suppresses the other when either is supplemented heavily. **Don't supplement both simultaneously**; separate dosing by at least several hours if both repletions are needed.

S/Cu RATIO

READING	REFERENCE RANGE
1,163	1,359–6,146

Detoxification-capacity question â€" sulphur pathways and copper handling share clinical ground through methylation and oxidative-stress pathways. **NAC or glutathione precursors** when clinical detox-strain signs are present (chemical sensitivity, slow medication clearance).

Zn/Fe RATIO

READING	REFERENCE RANGE
5.2	6.19–36.5

Absorption-level competition, usually **disadvantaging zinc** since iron supplementation tends to be higher-dose. Separate zinc and iron supplementation by at least two hours; ideally opposite meals. Both absorbed best away from calcium and fibre blockers.

Entries shown mildly out of reference range — see bar chart on page 1 for context.