

THE ELEMENTS: A LOVE LETTER TO ALL THINGS EVERYWHERE

Hannah Burr

An artist's book about the periodic table
and our inseparability from everything

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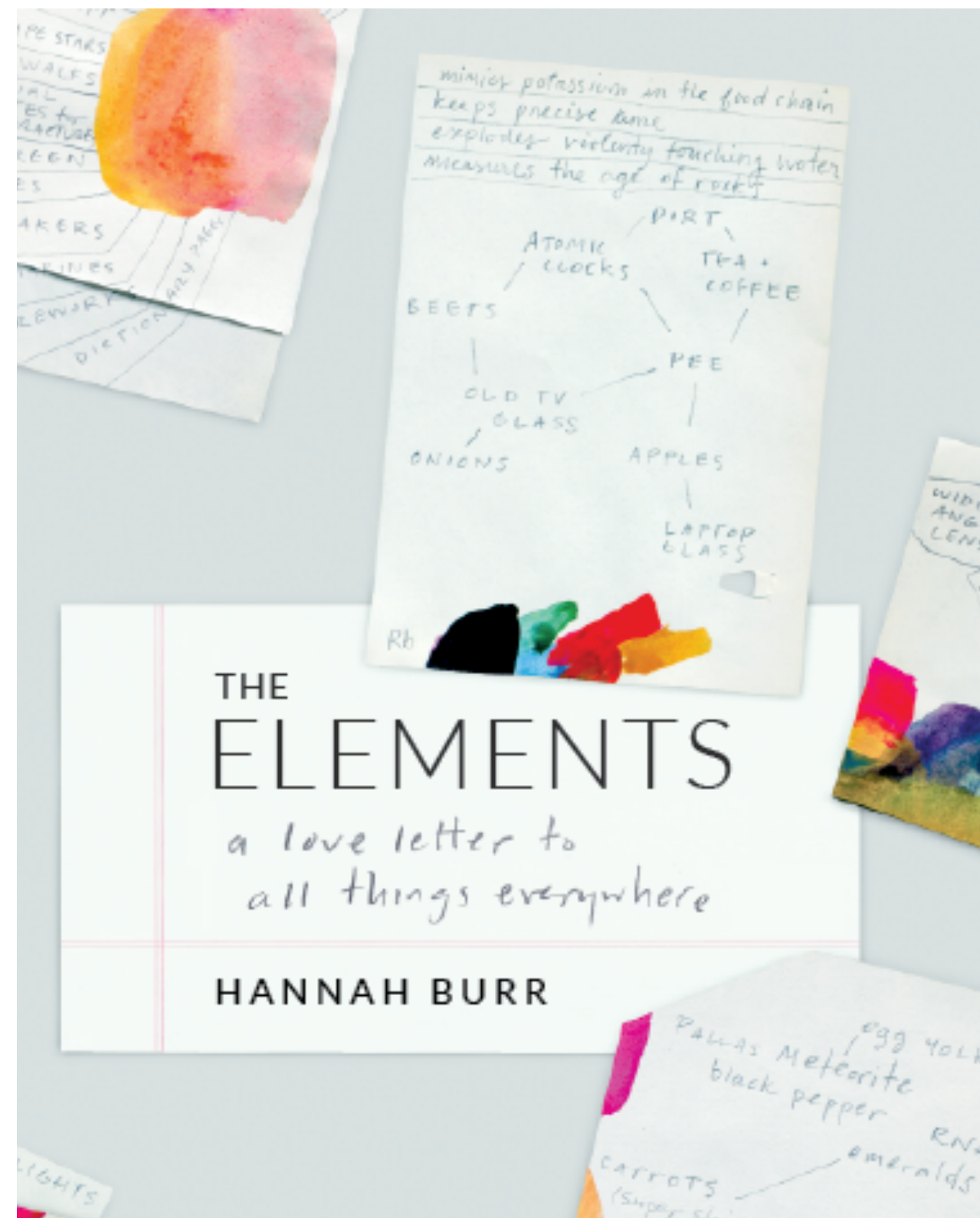
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The Elements:
a love letter to all things everywhere

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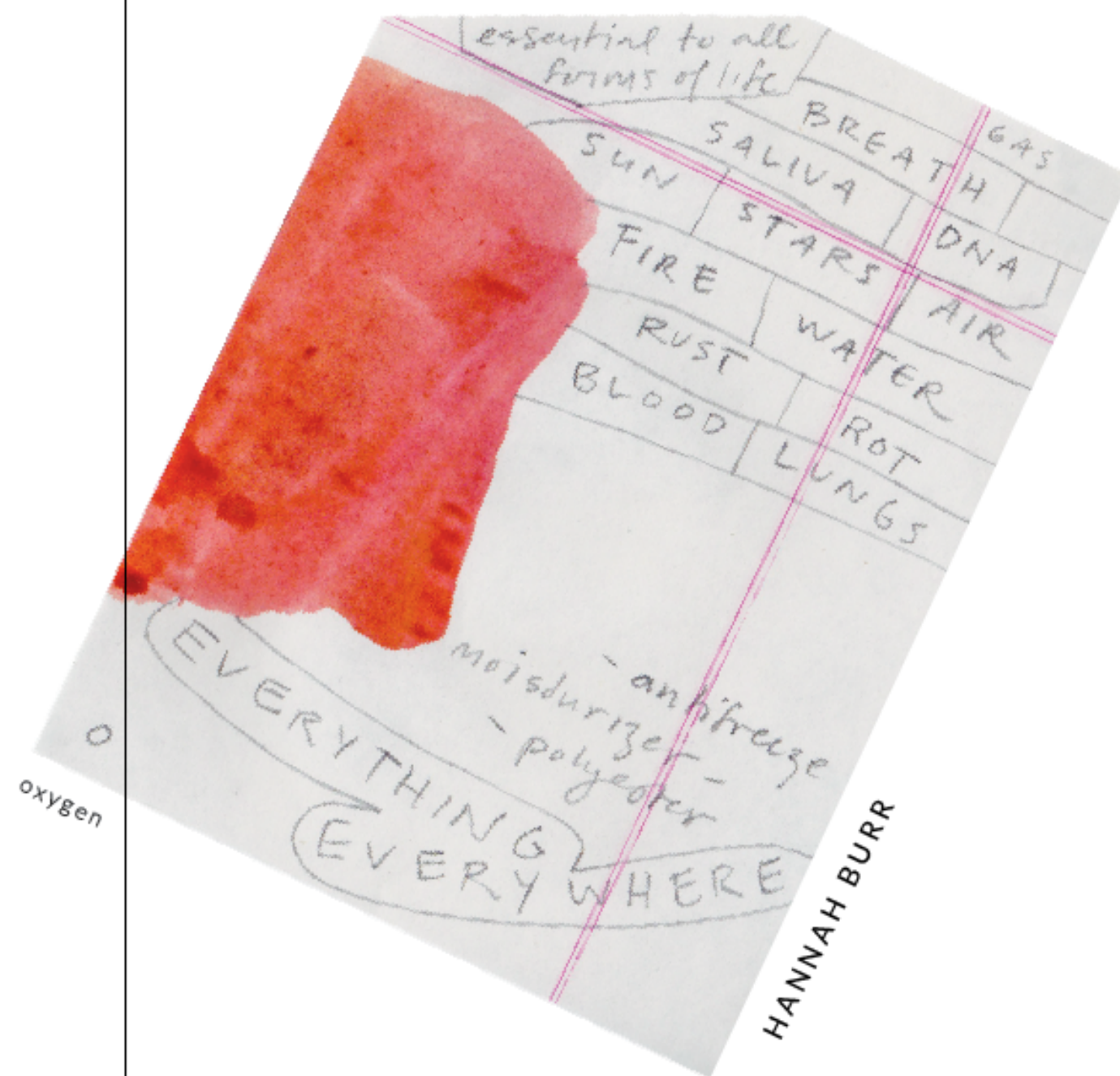
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THE ELEMENTS

A LOVE LETTER TO ALL THINGS EVERYWHERE



DIRECTORY OF ELEMENTS

Actinium.....Ac	198, 229	Lithium.....Li	26, 309	Terbium.....Tb	150, 389
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From the first, not a thing is.

– HUI NENG

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*There's no way to remove the observer – us –
from our perceptions of the world.*

– STEPHEN HAWKING

Every atom in your body was once inside a star that exploded...the atoms in your left hand probably came from a different star than in your right hand, because 200 million stars have exploded to make up the atoms in your body.

– CARL SAGAN

The universe is the smallest divisible unit.

– GEORGE SHEEHAN

INTRODUCTION

This book is the project of a contemporary artist. It is a playful re-encounter with everything around you. It reintroduces the world of stuff via the elements of the periodic table. These are the unique ingredients that comprise everything in the known universe, the primary content of all matter, including the taste in your mouth and the folds of your eyelids.

In this book you will **not** find

- The names, dates and stories of men of science
- Latin roots of element names or stories of their discovery
- Scientific jargon, expert language or math equations

The information in this book is yours – it is about what you and what everything around you are made out of.

When the brain spins stories of problem, worry, loneliness or doom (as it does), please open to any page. Look at the colors – let them seep in. These 94 ingredients suggest some astonishing things about you. The farthest reach of space, it turns out, is your birthplace. The ocean is what you carry around in your veins. You are not outside of anything, nor as separate as language and convention indicate. May you recall here the incredible unlikelihood of your alive state, your very life.

HOW THIS BOOK CAME TO BE

In high school, I was shown a version of this:

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium									5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon		
11 Na Sodium	12 Mg Magnesium									13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon		
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Cesium	56 Ba Barium	57-71 Lanthanides	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89-103 Actinides	104 Db Dubnium	105 Sg Seaborgium	106 Bh Berkelium	107 Hs Hassium	108 Mt Moscovium	109 Ds Darmstadtium	110 Nh Nihonium	111 Rg Roentgenium	112 Cn Carlsonium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson
57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium			
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium			

The Periodic Table of Elements. I was told to memorize it, along with a lot of related scientific information I no longer recall. It was something to study and get graded on because that's what we were supposed to do. I didn't learn then that the element sulfur smells like rotten eggs or that slimy, oniony texture comes from the element selenium. Or that things that are opaque and bright white often have the element titanium or zinc in them. I didn't learn then that the pencil I hold, the water I'm drinking, the clothes I wear, my skin, eyeballs and bones, as well as the sun shining on me, are the same elements in different combinations and that nothing, including me, is without them. I didn't learn then that they, you and I are born in stars.

I memorized names, dates and stories of long-dead chemists, stories of triumph and industry. For this book, I've stripped away everything except you, me, and these basic ingredients of our world: their distinct qualities, behaviors, and the forms they take both inside and outside of our bodies.

HOW TO USE THIS BOOK

1. Any way you like.
2. As a colorful reference tool for your body and world.
3. As an art book that includes two complete series of works on paper, over 200 ink and graphite drawings.
4. As a contemplative tool to explore your inherent inseparability from everything.
5. As a way to learn about and introduce others to the elements.

In the Overview section, learn where elements come from, their relative amounts in various realms, and what's around and in you right now.

The Element Sketches are a colorful meander through each element from lightest to heaviest, a visual juxtaposition of a few of the wild objects and places where each is found. The Element Index pairs with a second series of drawings. This section lists the distinct behaviors, qualities and uses of each element, along with a more comprehensive list of objects where each element can be found. The book's main index follows as a handy way to cross-reference objects and explore themes, referencing primarily the lists.

We are living in a time of amazing discovery and rapid change.

Unusual states of matter beyond solid, liquid and gas have recently been found, and predicted 'islands of stability' for elements previously too fleeting to study keep us exploring. Hypothetical new elements beyond the known 118 bring new dimensions to the conversation as well. These developments render our shared experience mind-blowingly stranger than fiction, and yet still so intimately right here and all around you.

May this book inspire you and remind you of your place in things,
your inherent belonging and naturalness as an object among objects,
constantly, intimately, in relationship with all things everywhere.

Every atom belonging to me as good belongs to you.

– WALT WHITMAN

THE PERIODIC TABLE OF ELEMENTS																			
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3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon		
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37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon		
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OVERVIEW

HOW ELEMENTS HAPPEN

THE ELEMENT HYDROGEN MAKES UP 75% OF ALL ATOMS IN THE UNIVERSE. ALL HYDROGEN RESULTED FROM THE BIG BANG, 13.8 BILLION YEARS AGO

H, He, Li, Be



THE BIG BANG

The explosion that is said to have begun the universe, about 13.8 billion years ago

After the Big Bang cooled down, atoms of hydrogen and helium formed, with trace amounts of lithium and beryllium: the four lightest elements

Eventually, denser pockets of gas collapsed under their own gravity and produced stars

THE REST OF THE ELEMENTS FORM AS STARS BURN OUT, EXPLODE, COLLIDE WITH ONE ANOTHER, AND AS COSMIC RAYS HIT STUFF

MAIN SEQUENCE STAR (LOW MASS STAR)

Ranges from 1/10th to 200X the mass of our sun
90% of all stars are this type, including our sun



MASSIVE STAR

8 to 50X the mass of our sun, these stars burn bright, fast, hot and die young, collapsing and exploding

The hotter stars burn, the brighter and bluer they appear

RELEASED IN TYPE II SUPERNOVA EXPLOSIONS:

*** C, N, O, F,**
Ne, **Na, Mg,** Al, Si,
P, S, Cl, Ar, **K, Ca,**
Sc, Ti, **V, Cr, Mn,**
Fe, Co, Ni, Cu, Zn,
Ga, Ge, As, **Se, Br,**
Kr, Rb, Sr, Y, Zr, Np



RED GIANT STAR (DYING LOW MASS STAR)

Dims and becomes redder as it burns through its helium



TYPE II SUPERNOVA (EXPLODING MASSIVE STAR)

How massive stars meet their end: a violent and massive explosion

RELEASED AS RED GIANT STARS BURN:

Li, **C, N,** Sr, Y,
Zr, Nb, **Mo,** Ru, Rh,
Pd, Ag, Cd, In, **Sn,**
Sb, Te, **I,** Xe, Cs,
Ba, Hf, Ta, W, Re,
Os, Ir, Pt, Au, Hg,
Tl, Pb, La, Ce, Pr,
Nd, Sm, Eu, Gd,
Tb, Dy, Ho, Er, Tm,
Yb, Lu



WHITE DWARF

When the helium is spent, the outer shell blows away (a nebula), and only the core remains



MERGING NEUTRON STARS

A neutron star is a small and dense star, the collapsed core of a massive star

When two neutron stars get into close orbit, they collide and produce either a black hole or a bigger neutron star

CREATED AS NEUTRON STARS MERGE:

Nb, **Mo,** Ru, Rh,
Pd, Ag, Cd, In, **Sn,**
Sb, Te, **I,** Xe, Cs,
Ba, Hf, Ta, W, Re,
Os, Ir, Pt, Au, Hg,
Tl, Pb, Bi, Po, At,
Rn, Fr, Ra, La, Ce,
Pr, Nd, Sm, Eu, Gd,
Tb, Dy, Ho, Er, Tm,
Yb, Lu, Ac, Th, Pa,
U, Np, Pu



PLANETARY NEBULA (STAR NURSERIES)

Clouds of dust and gas where stars both die and start to form

Stars are always burning out and being recreated in nebulae

CREATED AS WHITE DWARFS EXPLODE:

Si, S, Cl, K, Ca,
P, Ar, Sc, Ti, **V, Cr,**
Mn, Fe, Co, Ni,
Cu, Zn



EXPLODING WHITE DWARF

When another star gets close to a white dwarf, they can explode

A white dwarf is roughly the volume of Earth and the mass of our sun

CREATED IN COSMIC RAY FISSION:

Li, Be, **B**



COSMIC RAYS

Particles that bounce around in space nearing the speed of light

Cosmic rays hit types of matter and cause reactions called fission

There are 118 known elements, 94 of which occur naturally on Earth.

60 of these comprise our bodies. H, N, O and C make up 94% of us.

An ATOM is the smallest unit of an element. Each element has its own unique atomic structure.

*** VITAL IN YOUR BODY
TRACE IN YOUR BODY**

YOU ARE 10% HYDROGEN

You can know reality only when you are astonished.

SARGADATTA MAHARAJ

ELEMENT SKETCHBOOK

The following sketches share a few of my very favorite and strange juxtapositions of the qualities and quirks of each element, and the objects in which they are found. There is one sketch per element and they are listed from lightest to heaviest, as they are in the periodic table. The colors and composition emerged spontaneously. The Element Index, which follows this section, provides a more detailed listing of the “where” and “what” of elements in all things.

I use both found papers and map-like legends in many art projects. The legend on the next page will help you find patterns visually in the 118 element sketches.



BORON

B

Created in cosmic ray fission

BORON

Eye wash, the fragrance of hyacinths, Pyrex glass, cleaning agent, tank armor, fake snow, ceramic glaze, cherries, detergent, Death Valley.

Fireproof, magnetic, sparkly, vital to plants.

Burns green.

TITANIUM

Ti

*Created in exploding massive stars and
exploding white dwarf stars*



TITANIUM

Antibacterial Japanese faucets, paper, moon rock, food coloring, camping gear, spacecraft, M-type stars, sidewalks, cranial plates for skull fractures, sunscreen, missiles, pacemakers, submarines, fireworks, dictionary pages.

SELENIUM

Se

Created in exploding massive stars



SELENIUM

Garlic, thyroid, semiconductors, hair, skyscrapers, every cell in the human body, molasses, broccoli, sperm, fossil fuel, bread, lake sediment, night vision cameras, bones, old photocopies, yeast, tank slime.

Vital, smelly.



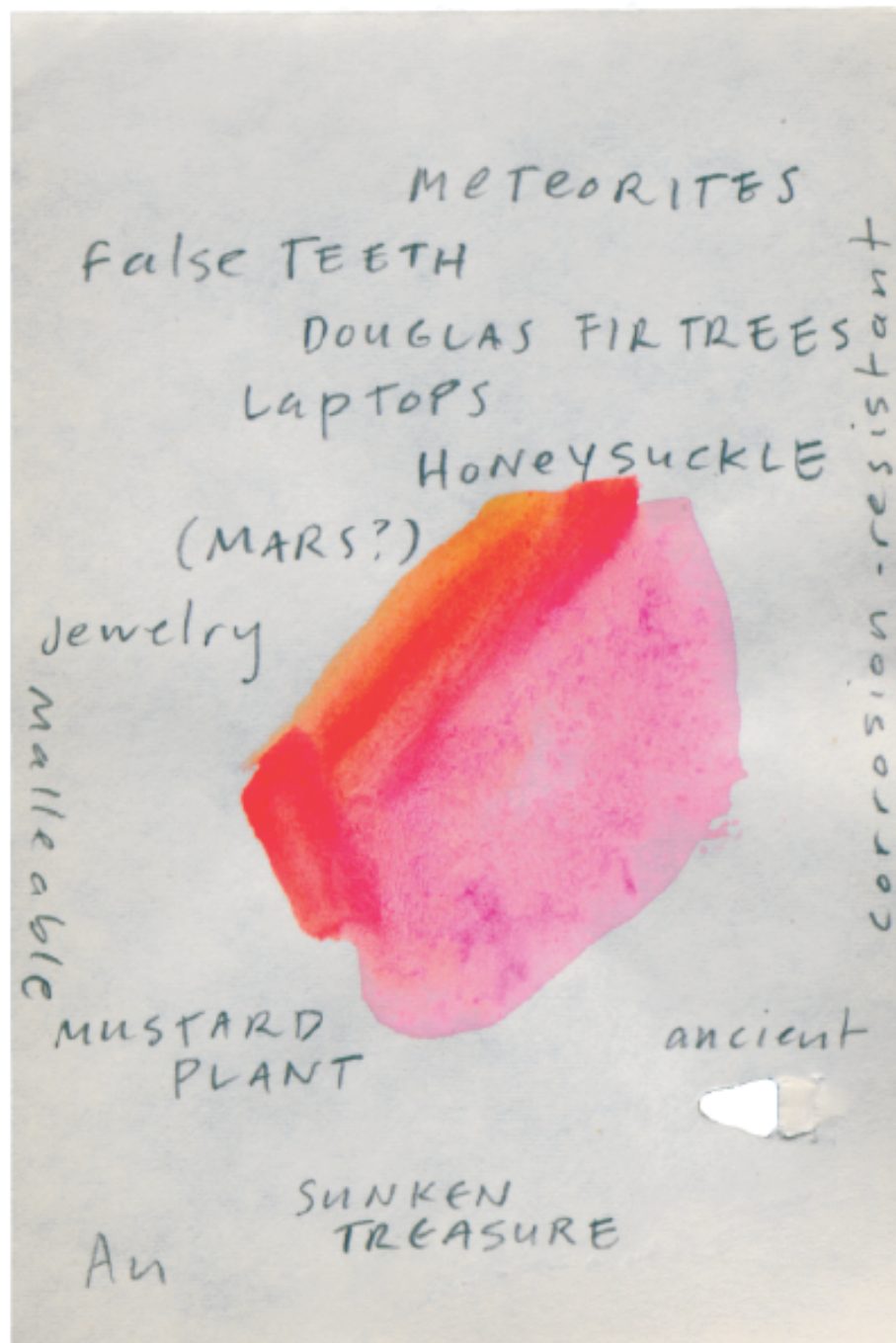
IODINE

Created in dying low mass stars and merging neutron stars

IODINE

Milk, skin, sea air, ovaries, cabbage, mouthwash, thyroid, printing dyes, daguerreotype photography, saliva.

Regulates growth, seeds clouds, controls body temperature, tests banknotes, accumulates in mushrooms.



GOLD

Au

Created in dying low mass stars and merging neutron stars

GOLD

Meteorites, false teeth, douglas fir trees, laptops, honeysuckle, jewelry, mustard plant, sunken treasure, (Mars?)

Malleable, ancient, corrosion-resistant.

*A human being is part of a whole, called by us the Universe,
a part limited by time and space. He experiences himself, his
thoughts and feelings, as something separated from the rest.
A kind of optical delusion of consciousness.*

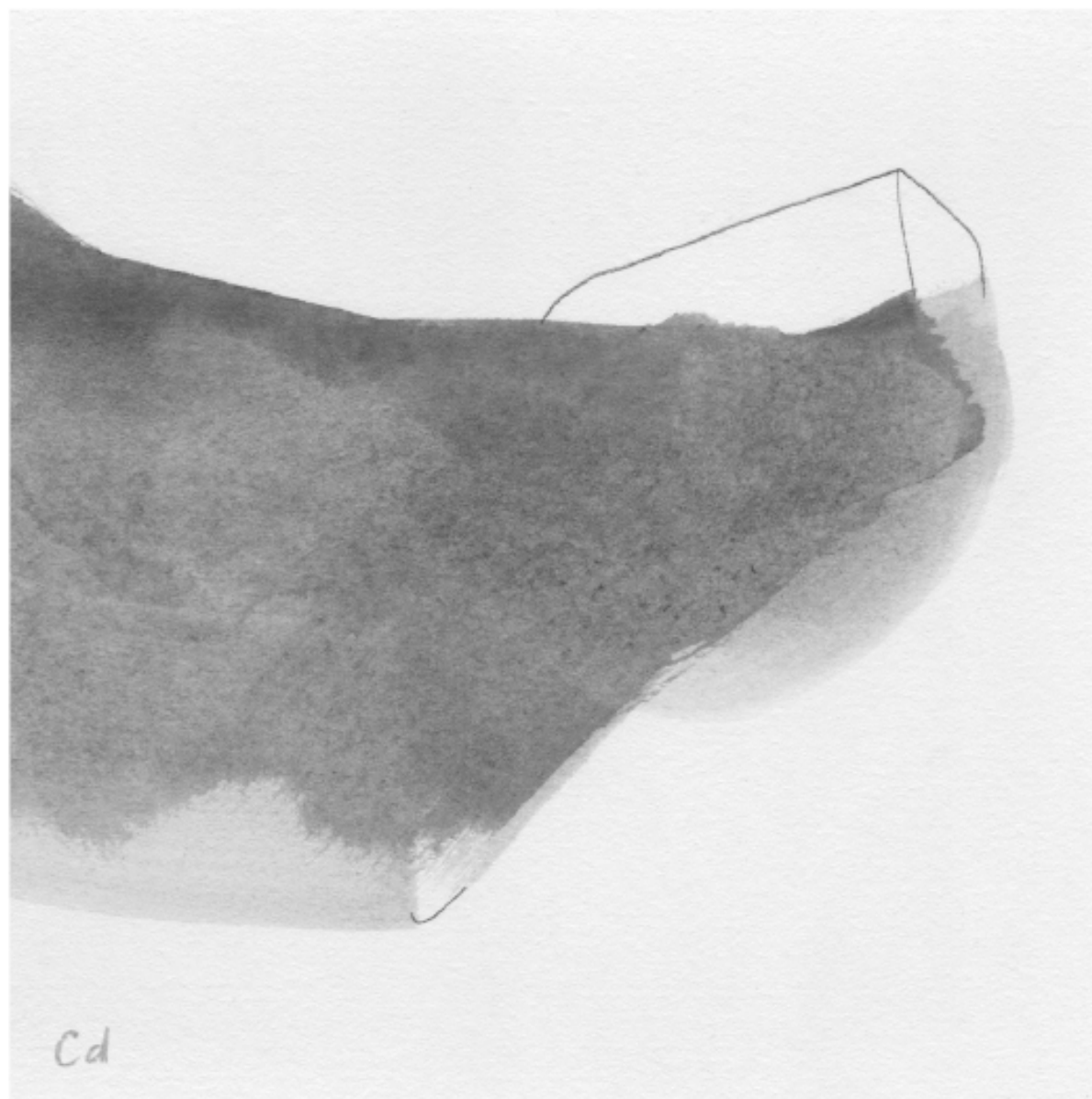
— ALBERT EINSTEIN

*To know what you are, you must first investigate and know what
you are not. Separate the 'I am' from 'this' or 'that' and ... feel
what it means to be, just to be, without being 'this' or 'that.'*

— SRI NISARGADATTA MAHARAJ

ELEMENT INDEX

This section pairs 94 abstract artworks, somewhat at random, with each naturally occurring element. Each spread includes an expanded list of objects in which this element is found, its qualities, behaviors and uses. Included are old-timey uses that have been discontinued but may still show up as an antique in your world. Also noted is the presence of each element in foods and the body. Parentheses around a noun here indicate that the element appears in minute amounts in that object, or in unusual circumstances. Elements are listed alphabetically here for easy reference.



CADMIUM

Created in dying low mass stars and merging neutron stars

QUALITIES

Silvery bluish
Red
Yellow
Soft
Toxic
Dangerous
Accumulative

BEHAVIORS

Soft enough to cut with a knife
Tarnishes in air
Similar toxicity to mercury
Essential for some marine life
One of the ten most hazardous pollutants
Remains in the human body for roughly 30 years
Mimics zinc in the body
Bad for the kidneys
Damages joints
Crop runoff lands it in foods
Ptarmigans suffer from it
Recycled from batteries

USES

Increases in concentration as you descend the ocean floor
Measure the wavelength of light
Coat steel against corrosive seawater
Make stable plastics

PRESENT IN

Zinc Ore + 22 known minerals
Fragile bones of ptarmigans
Amanita mushrooms
Cattle
Sheep
Pigs
Marine organisms
Tobacco
Electronic devices
Vitreous enamels
Zinc mines
Airplane landing gear

PRESENT IN

Orange, red, brown + yellow pigments
Solar panels
Printing inks
Rubber
Nickel cadmium batteries
Plastics
Rice
Lettuce
Spinach
Cabbage
Turnips
Corn
Beans
Potatoes
Shellfish
Livers + kidneys of cows + pigs

WAS IN

Old lead

Cd



COBALT

Created in exploding massive stars and exploding white dwarf stars

QUALITIES

Rare
Essential
Hard
Lustrous
Silvery-gray
Deep blue
Distinctive
Magnetic
Sensitive

BEHAVIORS

Remains unseen until warmed
Stable in air
Essential to everything that walks, crawls, flies or swims
Unaffected by water
Slowly attacked by acids
Can be magnetized
Colors diamonds blue
Essential in minute amounts
Emits toxic fumes

USES

Help animals metabolize
Convert gas to liquid fuel

USES

Treat cancer
Check for cracks in metal vats
Dry inks, paints and varnishes faster
Sterilize and pasteurize foods
Sterilize medical supplies + waste

PRESENT IN

Meteorites
Oceans
59 known minerals
Blue-green algae
Soil
Grasses
Violets
Myrtle
Invisible ink
Venetian blue glass
Foam stabilizers in beer
Sevres, Thenard + Cobalt Blue pigments
Prosthetics
Jet engines
High-temp cutting tools
Enamelware

PRESENT IN

Dental implants
Jewelry
Tank fill-height switches
Razor blades
Mobile phones
Electric cars
Eye drops
Hard drives

WAS IN

Corn
Lettuce
Oranges
Apples
Legumes
Vitamin B12
Seafood
Eggs
Artificial flowers that changed color with weather (1800s)
Blue glass
Laundry bluing
Land + sea mines (the Blitz)
Persian jewelry (Bronze Age)
Pompeii ruins, 79 AD
Tang + Ming Dynasty china

Co



IODINE

Created in dying low mass stars and merging neutron stars

QUALITIES

- Purple
- Brown
- Black
- Shiny
- Non-metallic
- Solid
- Heavy
- Vital

BEHAVIORS

- Forms black crystals and purple vapors
- Essential to all animals
- Fungi accumulate it
- Plants absorb it through atmosphere or soil
- Used with silver to seed clouds
- Lack of it leads to cretinism + goiter
- Its vapors irritate the eye
- Linked to deficiency diseases
- Released in nuclear accidents
- Not essential to plants

USES

- Regulate growth
- Control body temperature
- Develop the brain
- Test for counterfeit banknotes
- Make rain
- Kill germs
- Purify water
- Treat wounds
- Treat prostate cancer + thyroid cancer
- Screen for vaginal + cervical problems
- Make arty photographs

PRESENT IN

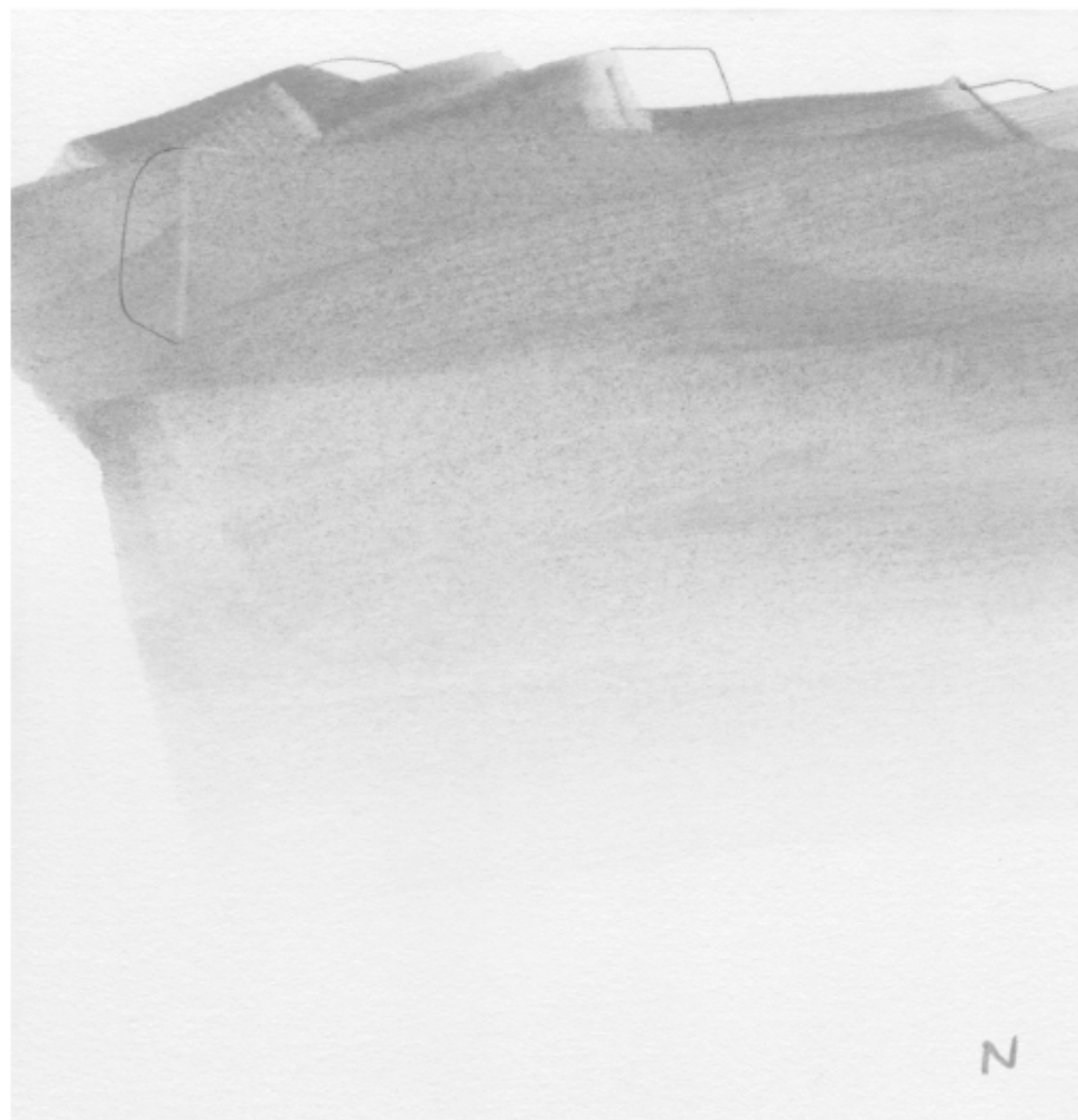
- Seaweed
- The atmosphere of coastal regions
- Soil
- 22 known minerals
- Fungi
- Seawater, brine
- Rivers
- Epidermis (skin)

PRESENT IN

- Thyroid gland
- Salivary gland
- Pituitary gland
- Stomach
- Ovaries
- Yellow antiseptic
- Cattle feed
- Printing agents + dyes
- Contrasting agents
- Drugs
- Soil fumigants
- Radioactive tracers in medicine
- Mouthwash
- Disinfectant
- Milk
- Seafood
- Table salt
- Cabbage
- Onions
- Mushrooms
- Rice

WAS IN

- Daguerreotype photography



NITROGEN

*Created in dying low mass and
exploding massive stars*

QUALITIES

Colorless
Odorless
Abundant
Inert
Explosive
Gaseous
Tasteless

BEHAVIORS

Needed by every
living thing
Part of the genetic
code
With oxygen,
is a pollutant
Slightly lighter
than air

USES

Inflate tires
Preserve things
Boost crop yields
Make cryogenics
possible:
freeze blood, eggs
and other genetic
material
Lower blood
pressure
Relax muscles
Make positron
emission photos
Refine oil
Make ammonia

PRESENT IN

Interstellar space
Atmosphere of
Saturn's moon,
Titan
Mars'
atmosphere

Earth's
atmosphere
Thunderstorms
Air
Greenhouse
gases
Rain
Seawater
Poop
Plant debris
Algae
Microbes in
deep sea,
hydrothermal
vents
Wood
Vegetation
People, alive
and dead
Some rare
minerals

Enzymes
Hemoglobin
Gut microbes

PRESENT IN

Brain
Neuro-
transmitters
Protein
Amino acids
DNA

Whipped cream
cans
Rocket engine
fuel
Airbags
Laughing gas
Beer bar taps
Gunpowder
Saltpeter
PET scans
Deep sea divers'
gas
Drugs for angina
Ultra-smooth ice
cream
Ammonia
Viagra
Smog over cities
Plastics
Fertilizers
Cryogenics
Dynamite
Drinking water

N

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