

Salt Partners

Salt for Life

Matthew 5:13: You are the salt of the earth.

Vladimir M. Sedivy MSc (Hons) Chem Eng, IMD

President

Salt Partners Ltd, Zurich, Switzerland

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First Book of Moses, Genesis

1:1 In the beginning God created the heaven and the earth.

1:3 And God said, Let there be light: and there was light.

Moshe Rabbenu 1391–1271 BC

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Gospel of John

1:1 In the beginning was the Word, and the Word was with God, and the Word was God.

John the Apostle 90 AC

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Big Bang

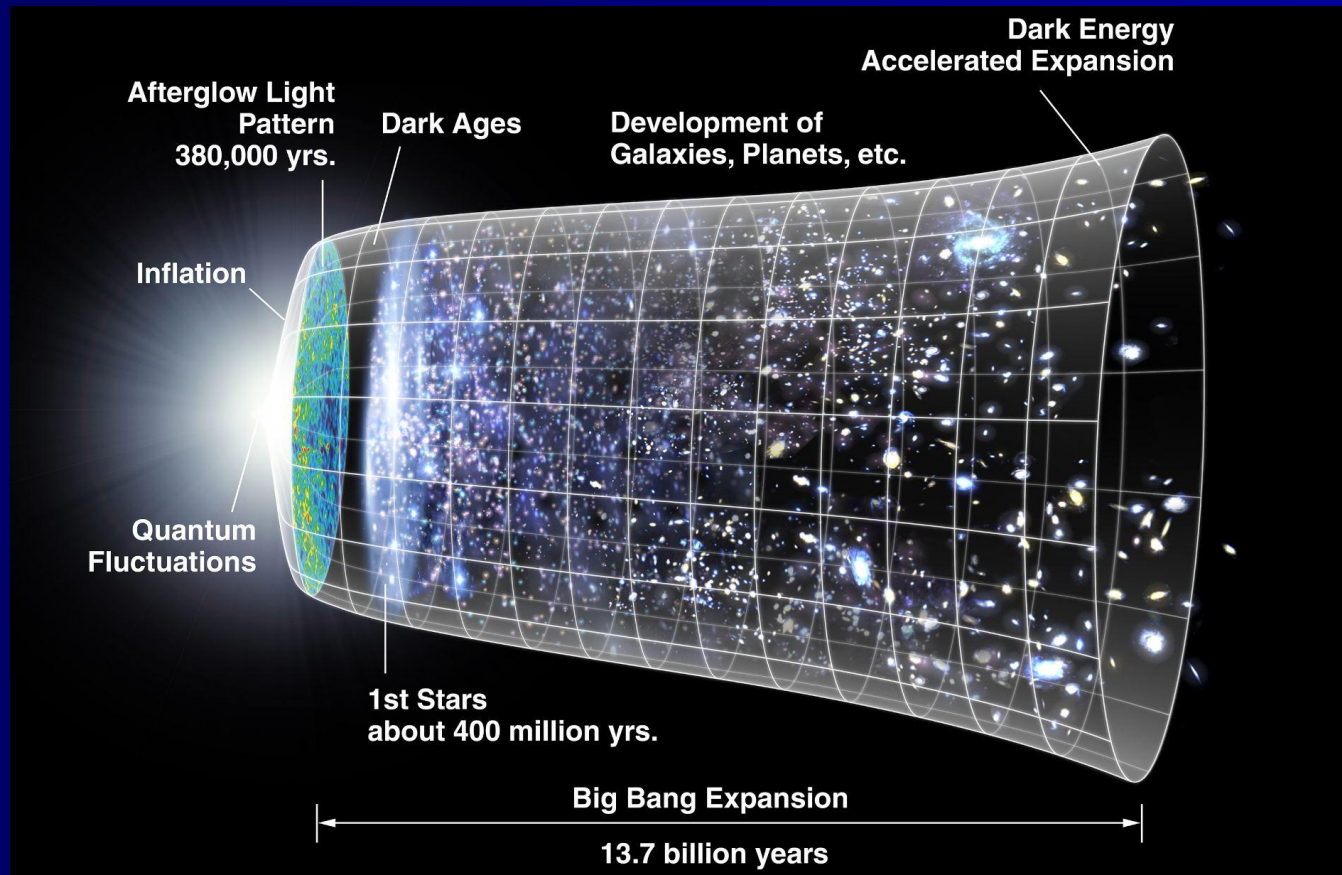
The Universe was born 13.75 billion years ago from an extremely hot and dense singularity, which expanded exponentially, causing it to cool and convert energy into subatomic particles. Quarks and anti-quarks were formed in nanoseconds after the bang, hadrons such as hydrogen nuclei in milliseconds, leptons – helium nuclei in minutes, followed by protons and neutrons combining with electrons to create electrically neutral atoms in 400'000 years.

Einstein Friedmann Lemaître Robertson Walker 1920-1930 AC

Kiwanis Manesse, Zurich, Switzerland, 13. July 2012

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History of Universe



**Earth formed
4.54 billion
years ago
and life
appeared on
its surface
within one
billion years**

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Elements

	I	II										III	IV	V	VI	VII	VIII	
1	<u>H</u> ₁	← Hydrogen and helium form 400'000 years after Big Bang →															<u>He</u> ₂	
2	<u>Li</u> ₃	<u>Be</u> ₄											<u>B</u> ₅	<u>C</u> ₆	<u>N</u> ₇	<u>O</u> ₈	<u>F</u> ₉	<u>Ne</u> ₁₀
3	<u>Na</u> ₁₁	<u>Mg</u> ₁₂											<u>Al</u> ₁₃	<u>Si</u> ₁₄	<u>P</u> ₁₅	<u>S</u> ₁₆	<u>Cl</u> ₁₇	<u>Ar</u> ₁₈
4	<u>K</u> ₁₉	<u>Ca</u> ₂₀	<u>Sc</u> ₂₁	<u>Ti</u> ₂₂	<u>V</u> ₂₃	<u>Cr</u> ₂₄	<u>Mn</u> ₂₅	<u>Fe</u> ₂₆	<u>Co</u> ₂₇	<u>Ni</u> ₂₈	<u>Cu</u> ₂₉	<u>Zn</u> ₃₀	<u>Ga</u> ₃₁	<u>Ge</u> ₃₂	<u>As</u> ₃₃	<u>Se</u> ₃₄	<u>Br</u> ₃₅	<u>Kr</u> ₃₆
5	<u>Rb</u> ₃₇	<u>Sr</u> ₃₈	<u>Y</u> ₃₉	<u>Zr</u> ₄₀	<u>Nb</u> ₄₁	<u>Mo</u> ₄₂	<u>Tc</u> ₄₃	<u>Ru</u> ₄₄	<u>Rh</u> ₄₅	<u>Pd</u> ₄₆	<u>Ag</u> ₄₇	<u>Cd</u> ₄₈	<u>In</u> ₄₉	<u>Sn</u> ₅₀	<u>Sb</u> ₅₁	<u>Te</u> ₅₂	<u>I</u> ₅₃	<u>Xe</u> ₅₄
6	<u>Cs</u> ₅₅	<u>Ba</u> ₅₆	<u>La</u> ₅₇	<u>Hf</u> ₇₂	<u>Ta</u> ₇₃	<u>W</u> ₇₄	<u>Re</u> ₇₅	<u>Os</u> ₇₆	<u>Ir</u> ₇₇	<u>Pt</u> ₇₈	<u>Au</u> ₇₉	<u>Hg</u> ₈₀	<u>Tl</u> ₈₁	<u>Pb</u> ₈₂	<u>Bi</u> ₈₃	<u>Po</u> ₈₄	<u>At</u> ₈₅	<u>Rn</u> ₈₆
7	<u>Fr</u> ₈₇	<u>Ra</u> ₈₈	<u>Ac</u> ₈₉	<u>Rf</u> ₁₀₄	<u>Db</u> ₁₀₅	<u>Sg</u> ₁₀₆	<u>Bh</u> ₁₀₇	<u>Hs</u> ₁₀₈	<u>Mt</u> ₁₀₉	<u>Ds</u> ₁₁₀	<u>Uuu</u> ₁₁₁	<u>Uub</u> ₁₁₂	<u>Uut</u> ₁₁₃	<u>Uuq</u> ₁₁₄	<u>UUp</u> ₁₁₅	<u>Uuh</u> ₁₁₆	<u>Uus</u> ₁₁₇	<u>Uuo</u> ₁₁₈

<u>Ce</u> ₅₈	<u>Pr</u> ₅₉	<u>Nd</u> ₆₀	<u>Pm</u> ₆₁	<u>Sm</u> ₆₂	<u>Eu</u> ₆₃	<u>Gd</u> ₆₄	<u>Tb</u> ₆₅	<u>Dy</u> ₆₆	<u>Ho</u> ₆₇	<u>Er</u> ₆₈	<u>Tm</u> ₆₉	<u>Yb</u> ₇₀	<u>Lu</u> ₇₁
<u>Th</u> ₉₀	<u>Pa</u> ₉₁	<u>U</u> ₉₂	<u>Np</u> ₉₃	<u>Pu</u> ₉₄	<u>Am</u> ₉₅	<u>Cm</u> ₉₆	<u>Bk</u> ₉₇	<u>Cf</u> ₉₈	<u>Es</u> ₉₉	<u>Fm</u> ₁₀₀	<u>Md</u> ₁₀₁	<u>No</u> ₁₀₂	<u>Lr</u> ₁₀₃

Formation of life is closely connected with the existence and properties of sodium chloride

Elements

	I	II											III	IV	V	VI	VII	VIII																												
1	<u>H₁</u>																		<u>He₂</u>																											
2	<u>Li₃</u>	<u>Be₄</u>											<u>B₅</u>	<u>C₆</u>	<u>N₇</u>	<u>O₈</u>	<u>F₉</u>	<u>Ne₁₀</u>																												
3	<u>Na₁₁</u>	<u>Mg₁₂</u>	Sodium and chlorine form billion years later										<u>Al₁₃</u>	<u>Si₁₄</u>	<u>P₁₅</u>	<u>S₁₆</u>	<u>Cl₁₇</u>	<u>Ar₁₈</u>																												
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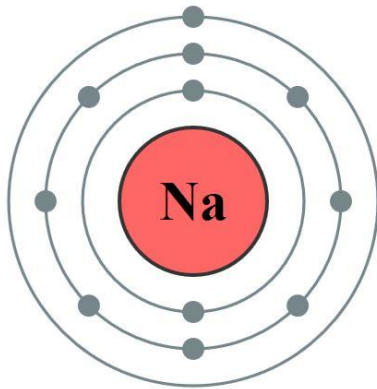
Formation of life is closely connected with the existence and properties of sodium chloride

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Sodium and Chlorine fit together like Adam and Eva

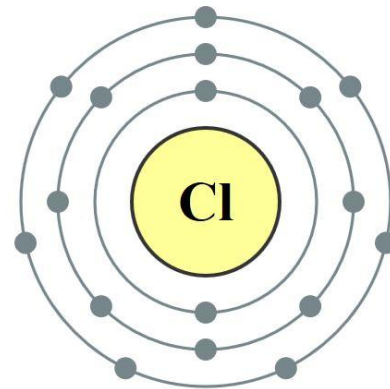
11: Sodium

2,8,1



17: Chlorine

2,8,7



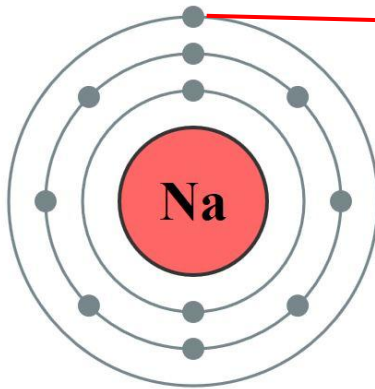
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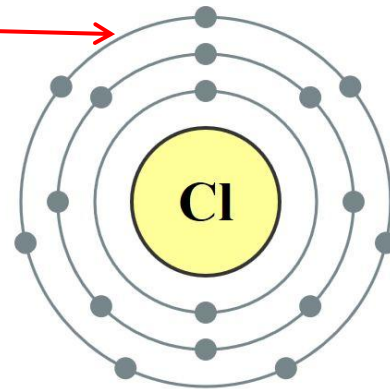
1



17: Chlorine

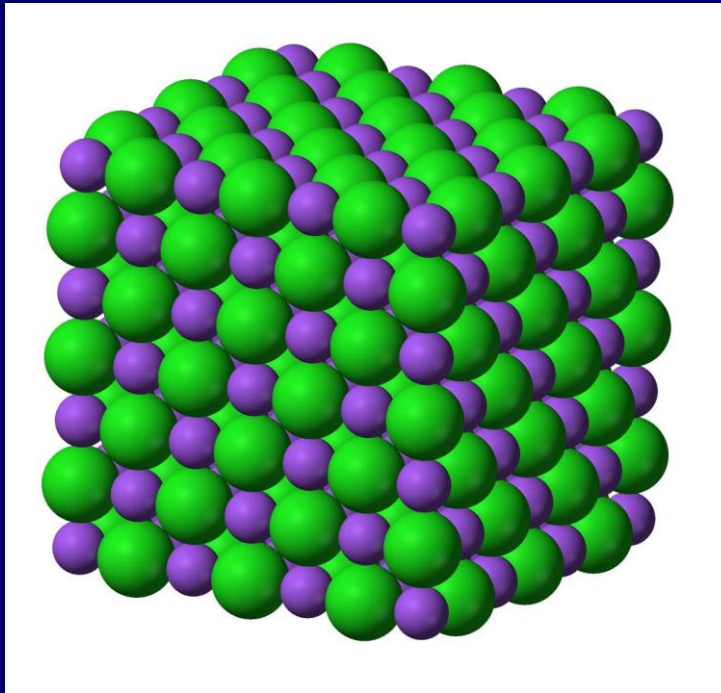
2,8,7

+ 7 = 8



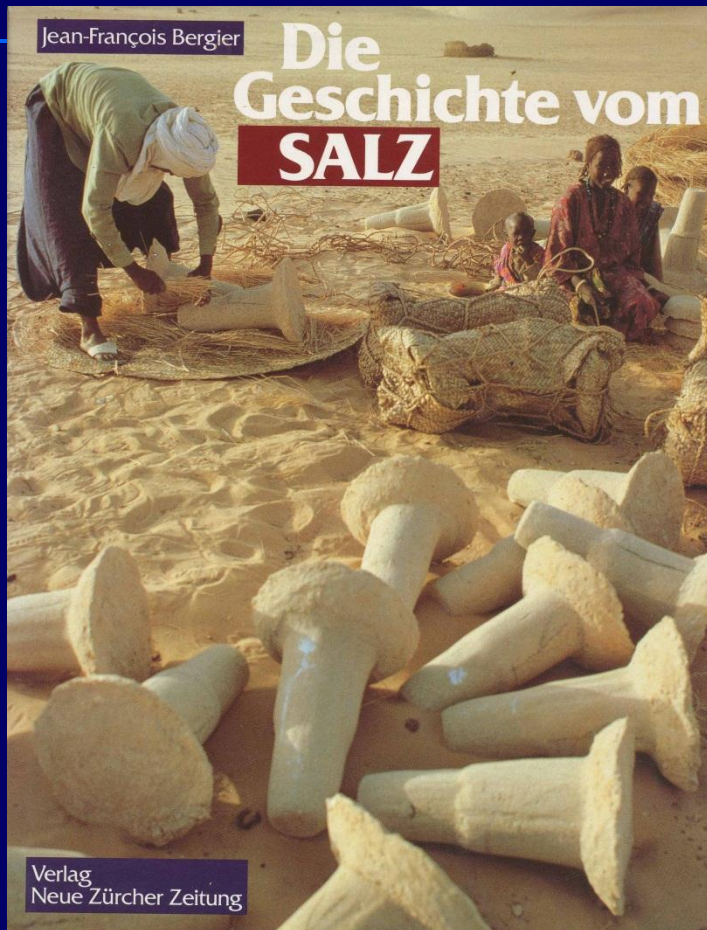
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Salt Crystal Matrix and Salt Crystal



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Salt on the Planet Earth



Woher kommt das Salz?

Unser Bedarf an einem so gewöhnlichen Produkt wie dem Salz ist also beträchtlich, aber glücklicherweise sind die potentiellen Salzvorräte schier unermesslich. Die Ozeane enthalten so viel Salz, daß, könnte man es kristallisieren und gleichmäßig über die Oberfläche unseres Planeten verteilen, daraus eine Schicht von 36 cm Dicke entstehen würde. Außerdem hinterließen die Urmeere des Paläozoikums und Mesozoikums auf und unter der Erdoberfläche riesige Lagerstätten aus mehr oder weni-

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Salt in the Oceans

- The area of the oceans is 361'000'000 km²
- The average depth of the oceans is 3,800 m
- The volume of ocean water is approximately 1'300'000'000 km³
- This corresponds to a cube of water with an edge length of 1'100 km
- The total mass of the seawater is about 1'400'000'000'000'000'000 t
- Average salt concentration in seawater is 3.5%
- Seawater contains 36'000'000'000'000 t of dissolved salt

Sources: Kali + Salz, Wikipedia, Morton Salt, Salt Institute

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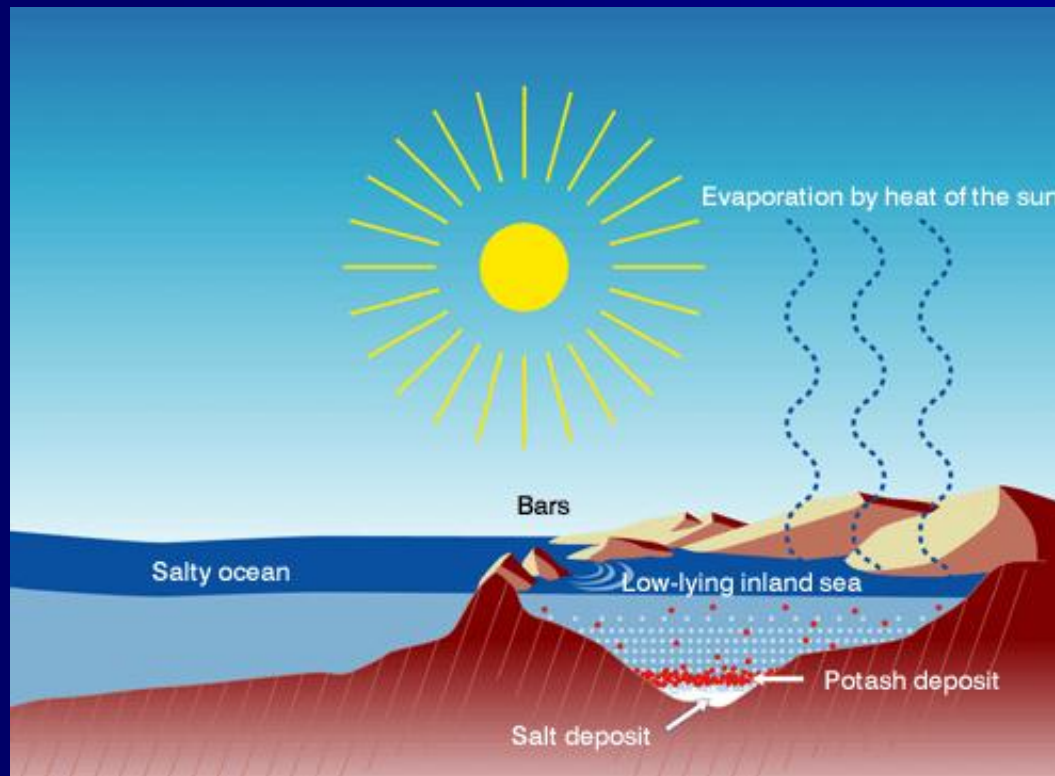
Salt in the Oceans

- The average depth of the oceans is 3,790 m
- The average salt concentration in seawater is 3.5%
- 3,800 m³ of seawater contain $3'800 \times 0.035 = 133$ t of salt
- Salt density is 2.16 t/m³
- 133 t of salt is $133 / 2.16 = 62$ m³ of salt
- 71% of Earth is covered with water
- Salt layer over the whole Earth would be $62 \times 0.71 = 44$ m

Source: Salt Partners

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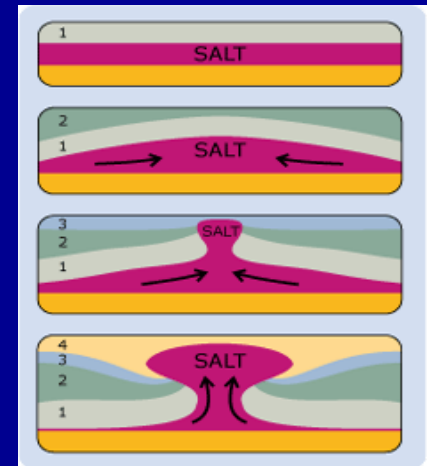
Formation of Rock Salt Deposits



The so called “barrier theory” postulates rock salt formation in sinking lakes connected to the oceans.

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Formation of Diapiric Salt Formations



Salt flows. Under pressure of heavy rocks salt finds weak strata and breaks through them to the surface

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Rock Salt Underground Mining

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Rock salt mining
using the “chamber
and pillar method at
European Salt
Company (esco) in
Bernburg, Germany



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Rock Salt Surface Mining



**Open-cast mining at
the Punta de Lobos
mine in the Chilean
Atacama Desert**

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February 2009: Flight over Australian Saltfields



On 2. and 3.2.2009, Salt Partners flew over some of the world largest solar saltfields. Isabella Sedivy was shooting pictures.

GOOGLE EARTH

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Shark Bay Salt Stockpiles



At Shark Bay, the stockpiles are 200m long and 60m wide. Their design capacity is 250'000 t. They were less than half full.

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Onslow Salt Stockpile

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Salt Partners Ltd, Zurich, Switzerland



Onslow stockpile was designed for 500'000 t of salt. On 2.2.2009, there was virtually no salt left. The picture shows the last salt shipment from Onslow in February 2009.

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Onslow Crystallisers

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Salt Partners Ltd, Zurich, Switzerland



The Onslow saltworks were flooded. Salt in one crystalliser was visible and was being harvested. Other crystallisers were inundated.

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Onslow Brine Ponds

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Salt Partners Ltd, Zurich, Switzerland



Onslow brine pond one week after it was hit by cyclone Dominic. Dykes were broken through at three locations. Brine was flowing out, to the sea. It took many months to restore full production.

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Destructive Climatic Change

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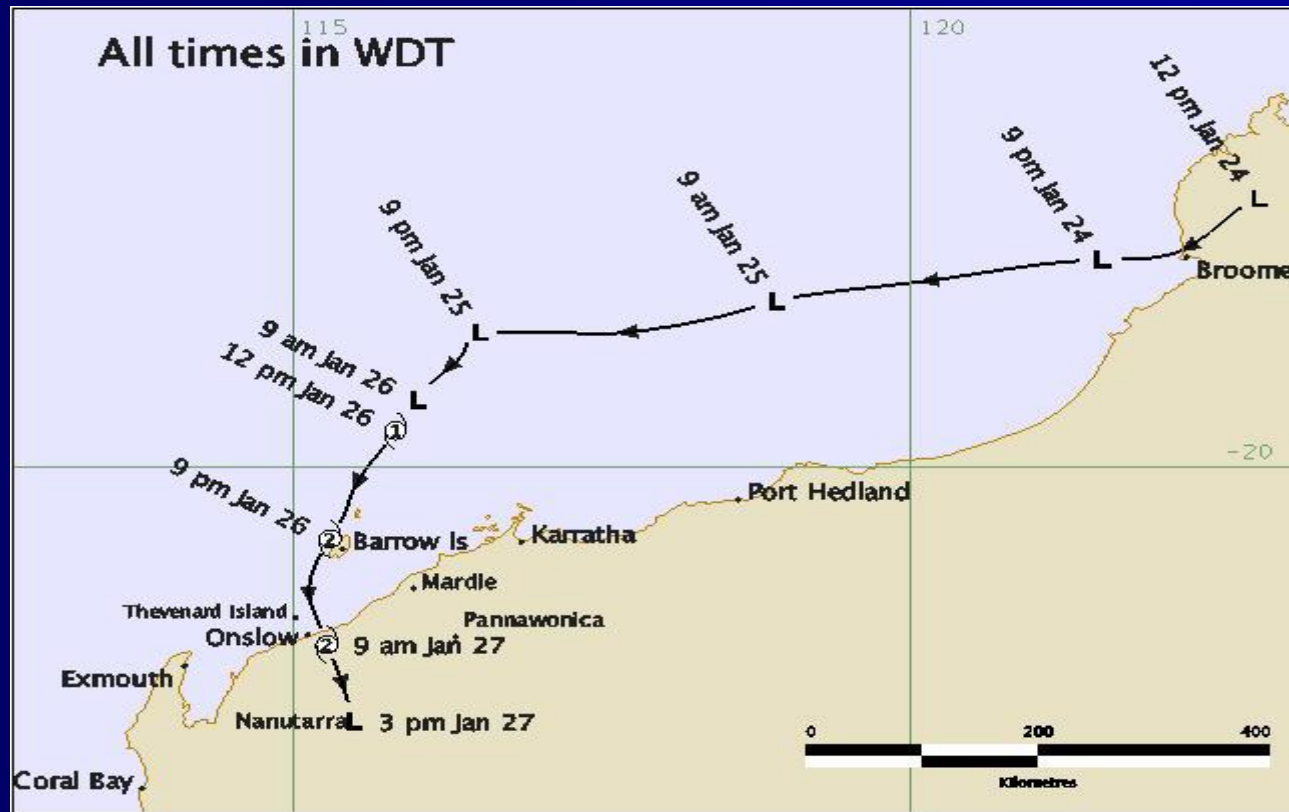
Increased hurricane activity is believed to be caused by global warming.

Groenteman

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Tropical Cyclone Dominic



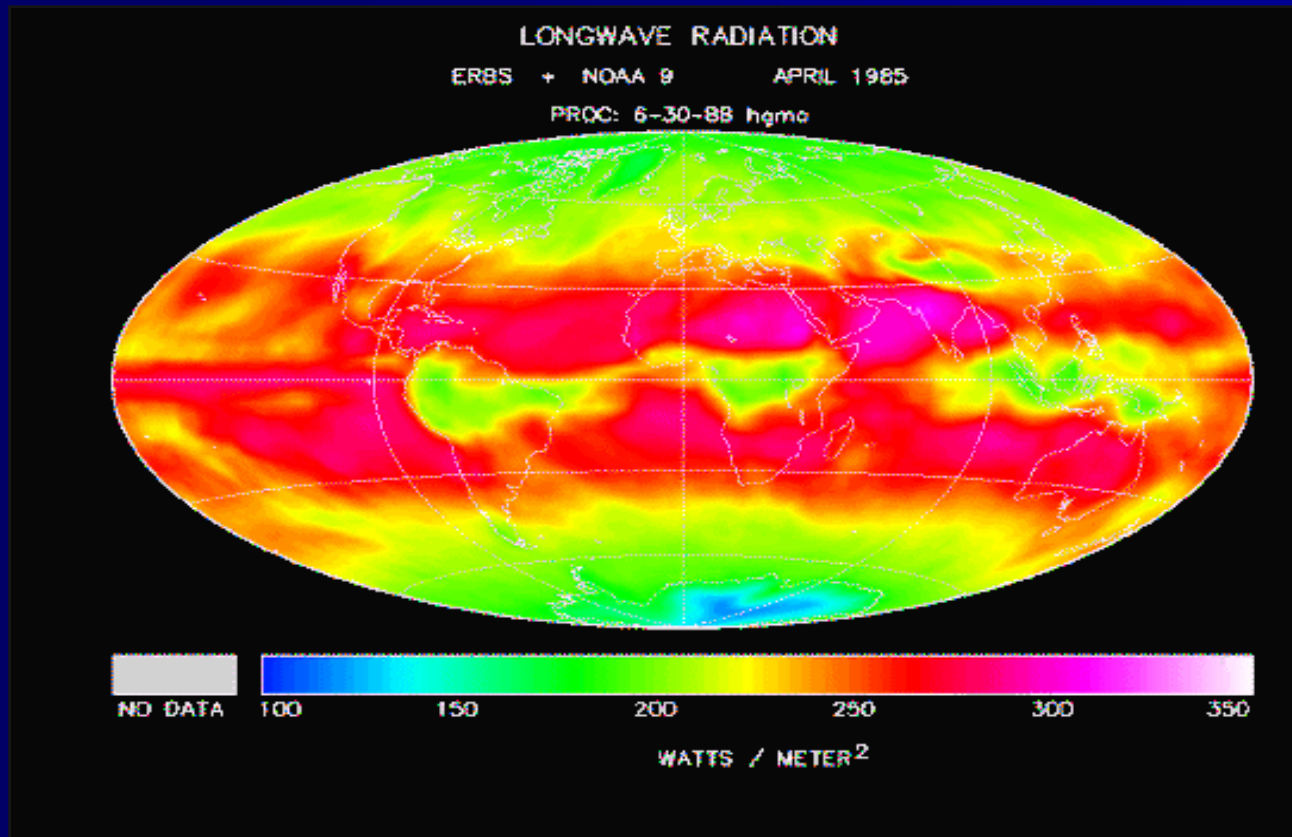
The Onslow saltfield was hit by tropical cyclone Dominic on 27.1.2009. Dominic was a moderate, category 2 cyclone with wind gust 140 km/h and 240 mm rainfall.

Australian Bureau of Meteorology

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Solar Energy on the Planet Earth



Locations with
highest rates of
evaporation,
suitable for solar
salt production:

**Caribbean Sea
North Africa
South Africa
Middle East
Western India
Western Australia**

NASA

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Locations



Mexico
Portugal
Bulgaria
Greece
Namibia
India
China
Australia

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Salt harvesting by bare hand



In Ghana, the most primitive salt harvesting method - by bare hand - is still being practised today.

MARIA ROCK

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Manual harvest and mechanised transport



In Bulgaria, the transport of the harvested salt has been mechanised but the salt is still being harvested by hand.

Two belt conveyors bring the salt to a slurring vessel mounted on a tractor.

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Salt harvesting in Portugal

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



In Portugal, salt is still harvested using an ancient method brought in by the Arabs in the Middle Ages.

However, also semi-mechanised and fully mechanised harvesting techniques are employed in modern saltworks.

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Messolongi harvesting system



At Messolongi in Greece, the harvester drives on the crystalliser mud bed.

The harvester cuts the salt in front of the machine and lifts the salt to a system of engine driven belt conveyors.

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Walvis Bay (Namibia) harvesting system



Walvis Bay salt harvesting system was supplied by ROV Durrant, Port Elizabeth, South Africa.

The harvester moves on Caterpillar tracks, both on the salt bed and on the crystalliser floor. Salt is loaded directly to the trailers.

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Salt harvesting in Walvis Bay, Namibia



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Salt production world-wide

Salt type	World production
Solar salt	90'000'000 t/y
Rock salt	80'000'000 t/y
Brines	80'000'000 t/y
Total	250'000'000 t/y

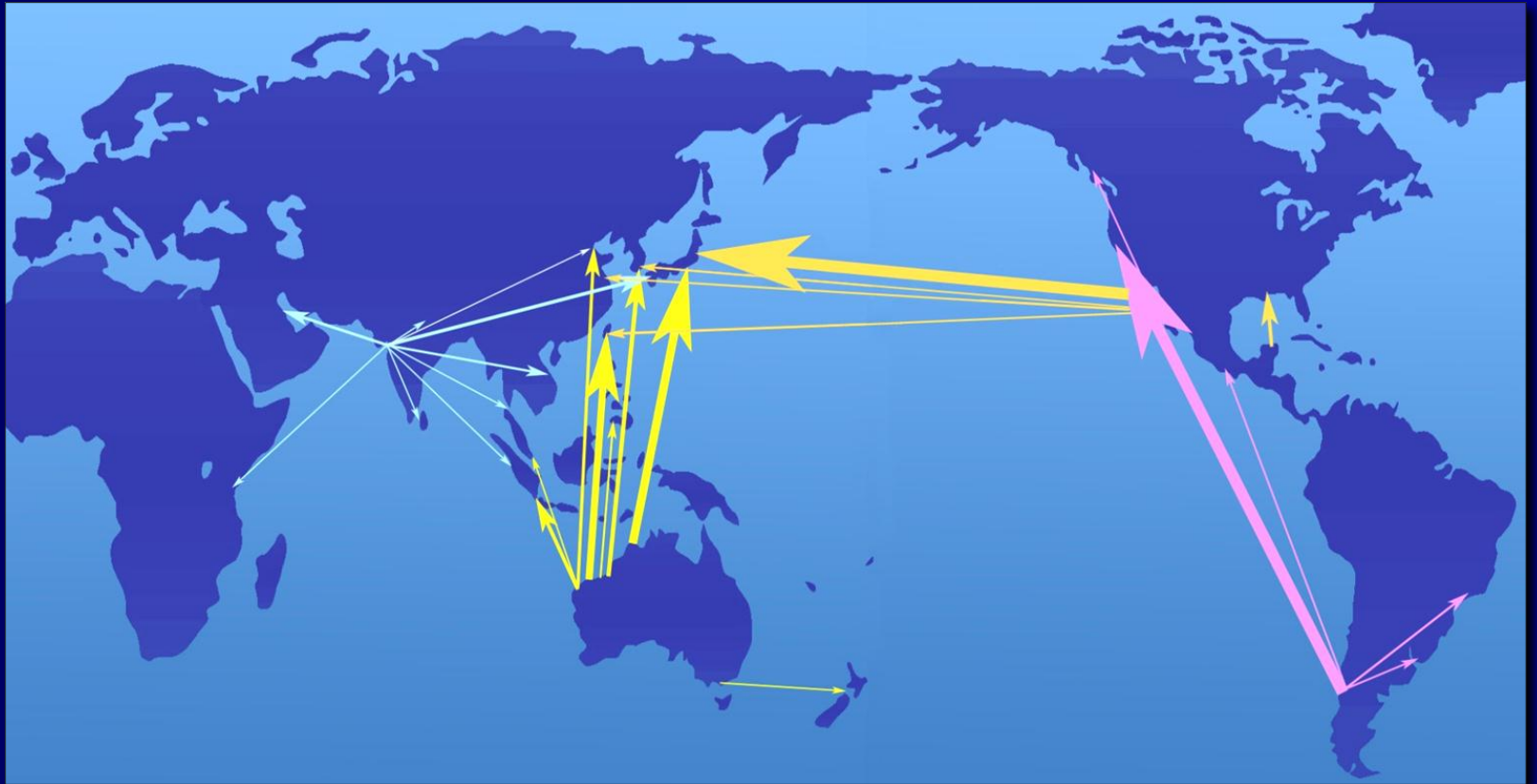
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Salt consumption world-wide

Salt user	Salt consumption
Chemical industry	150'000'000 t/y
Food	60'000'000 t/y
Other	40'000'000 t/y

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Bulk Salt Trade in Asia-Pacific



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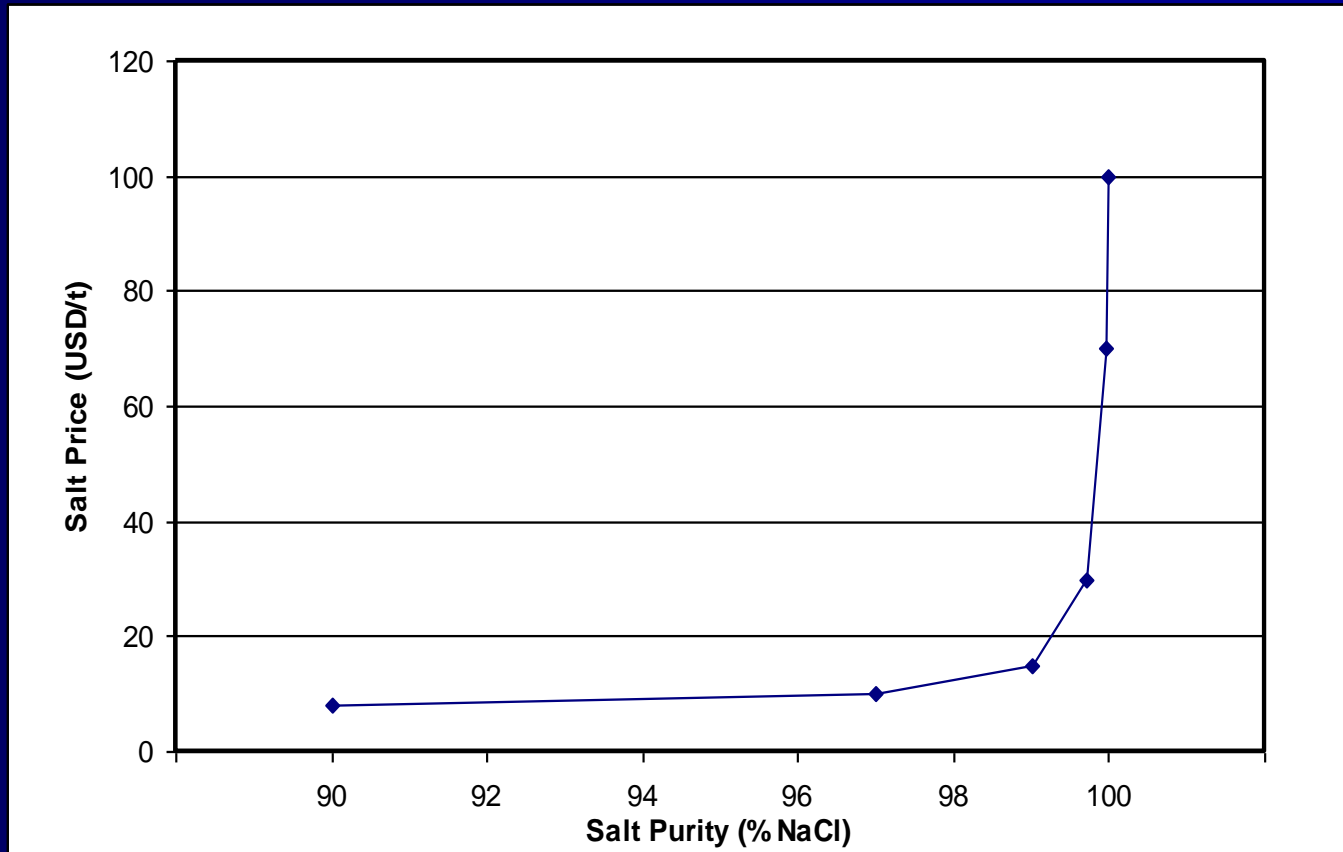
Salt Purities

NaCl Purity (%)

Rock salt	90 - 97
Crude sea salt	97 - 99
Washed sea salt	99 – 99.6
Purified sea salt	99.6 – 99.8
Refined salt	99.8 – 99.9
Vacuum refined salt	99.9 – 99.97
Ultrapure salt	99.97 – 99.997

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Salt Prices Depend on Salt Purity



Industrial salt prices vary between USD 10.-/t and USD 100.-/t depending on salt purity

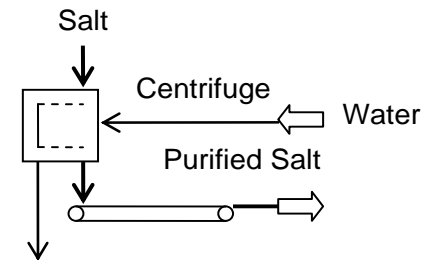
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HYDROSAL Process

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland

**Centrifuge separates
salt and brine**

**Conventional
washing with water in
the centrifuge**

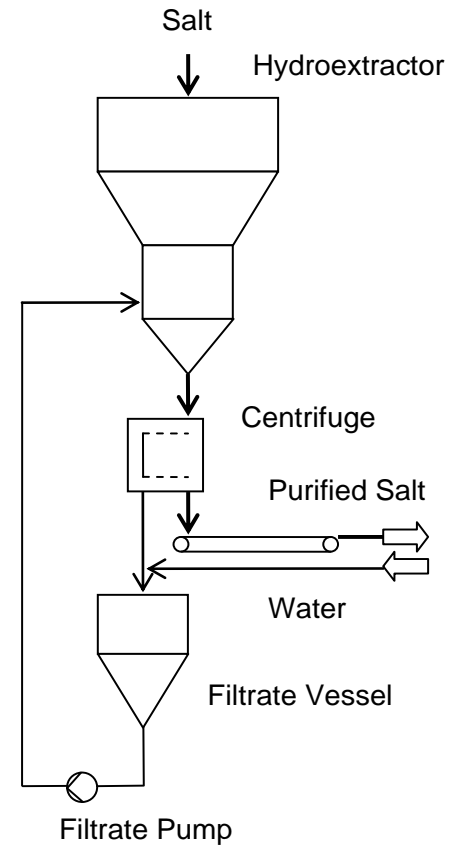


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HYDROSAL Process

Dissolve salt fines in water and use this pure brine to remove impurities from salt in the hydroextractor

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Salt Partners Ltd, Zurich, Switzerland

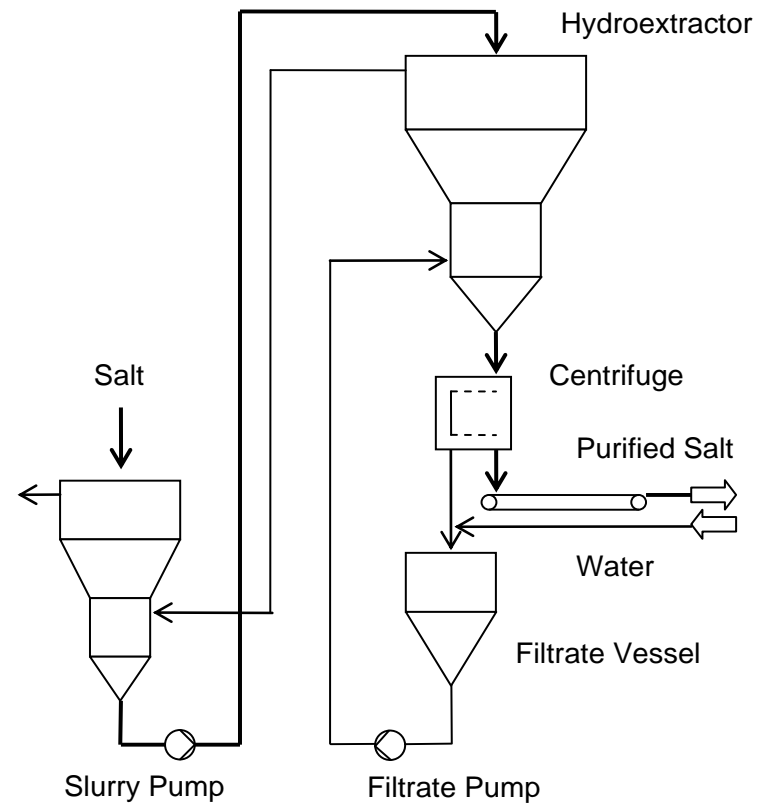


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HYDROSAL Process

**Hydraulically
transport salt to the
hydroextractor and
return the transport
brine to the elutriator**

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland

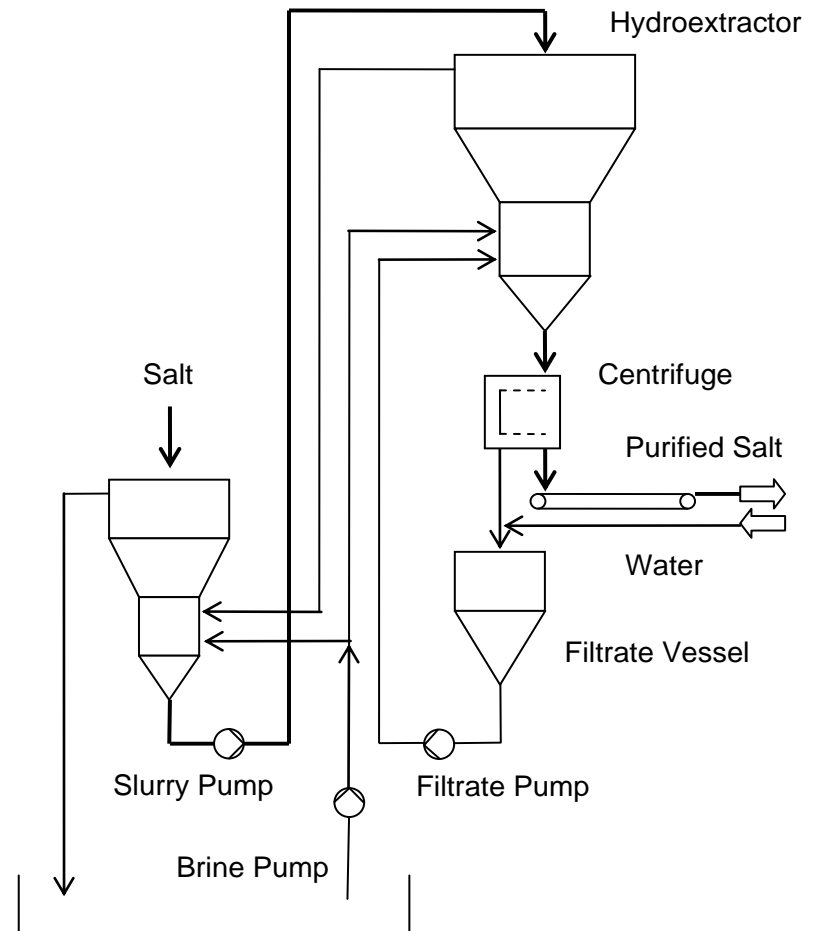


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HYDROSAL Process

**Circulate impure
brine to control
hydroclassification
and elutriation
efficiency**

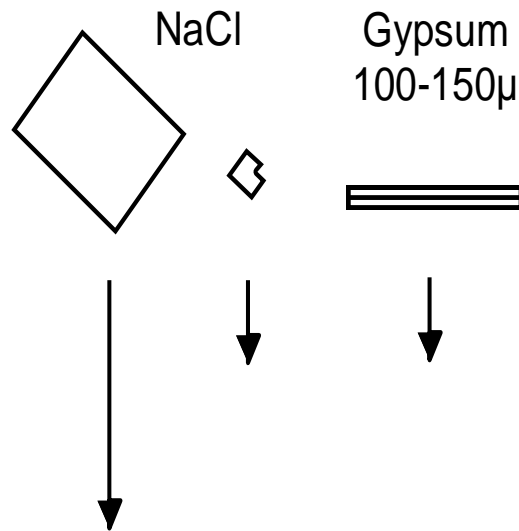
Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



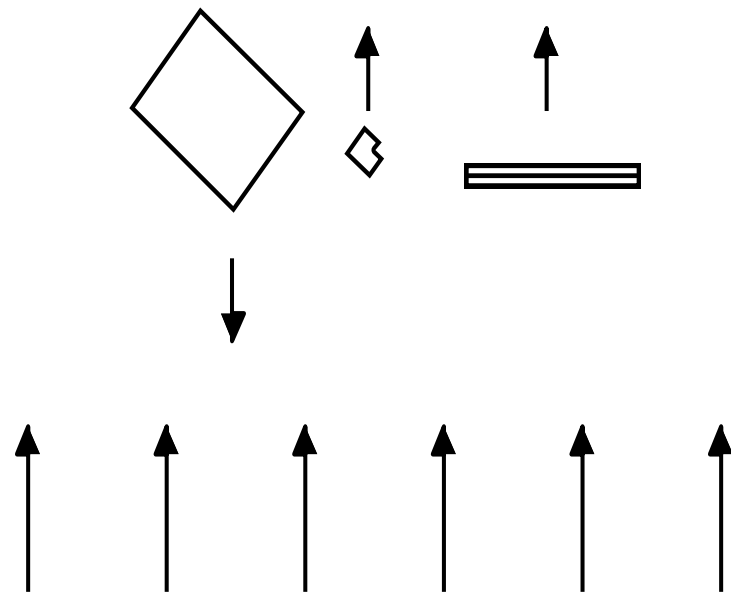
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Elutriation

Settling velocities in brine

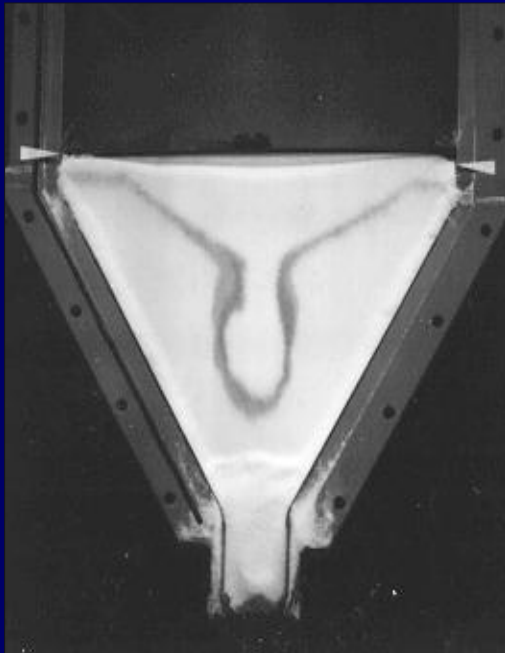


Elutriation in upwards flowing brine

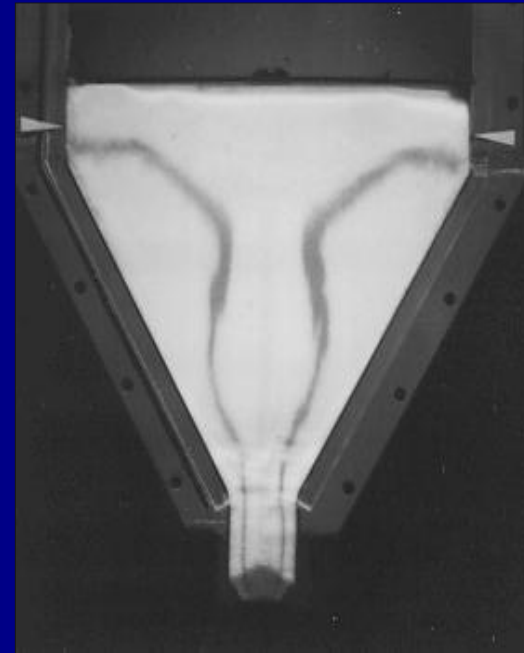


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Hydroextraction does not work in all vessels



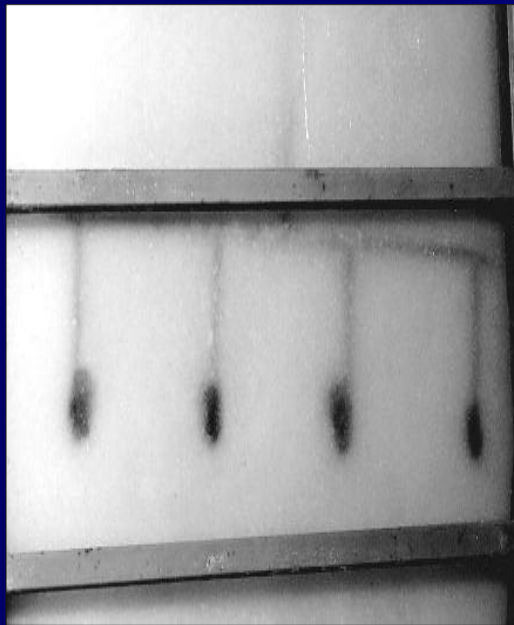
In this vessel salt flows out mainly through the centre



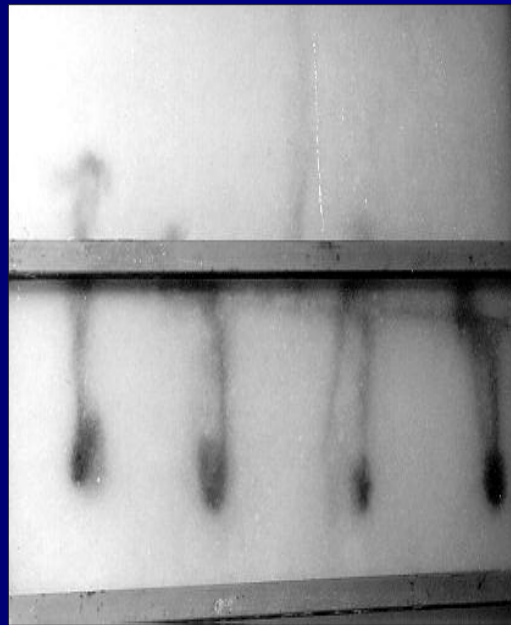
So called rat hole develops in the centre of the vessel

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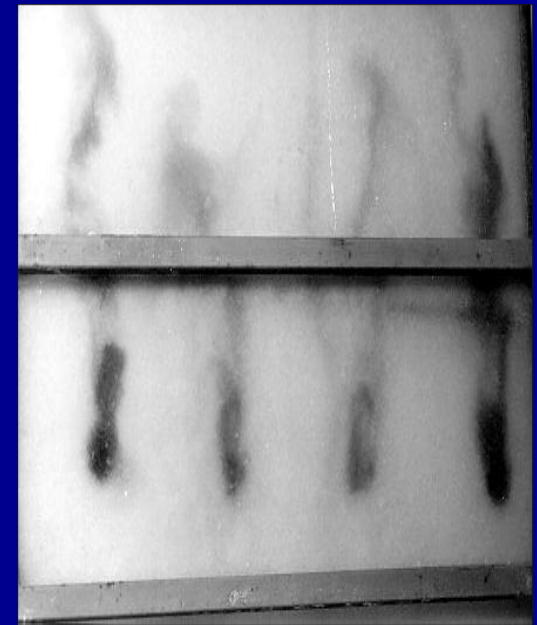
Hydroextraction works only with plug flow of salt



Picture 1: Injection of black ink into brine flowing upwards through salt flowing downwards in plug flow



Picture 2: Black ink flows upwards with brine in counter-current flow



Picture 3: Second black ink injection. There are no traces of black colour in the salt flowing downwards in plug flow

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Solution mining for natural gas storage, co-generation, brine purification, salt crystallisation and refining plant in Portugal

Kiwanis Manesse, Zurich, Switzerland, 13. July 2012

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Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland

**40 t/h salt purification
plant in Portugal
producing purest
industrial salt in Europe**

		Performance test
Ca	ppm	0.6
Mg	ppm	0.2
SO4	ppm	53

Kiwanis Manesse, Zurich, Switzerland,
13. July 2012



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Salt Partners Ltd, Zurich, Switzerland

SALEXPOR 15 t/h solar salt refining plant in Portugal

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Salt Partners supply technologies for production of salt according to “Australian standard”

**Modern industrial salt upgrading plant in Spain.
Capacity 500 t/h solar salt**

Kiwanis Manesse, Zurich, Switzerland,
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Salt Partners Prospect New Solar Saltfields

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Salt Partners Ltd, Zurich, Switzerland



Salt Partners assist their clients to prospect sites where new solar saltfields could be established.

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Why not turn your salt into gold?



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