

HEAVY SALINE STREAMS IN SALT DRIVEN WETLANDS, ABANDONED EVAPORATION PANS, DOMES AND OTHER SALT DEPOSITS AS THE RESPONSIBLE HYDRAULIC MECHANISMS CAUSING THE DISAPPEARANCE OF HEAVY WASTE LIQUIDS, AND OTHER WASTE TOXIC SEDIMENTS ON LAND AND IN THE OCEANS

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ABSTRACT

An hydraulic mechanism which dissolves salt to form so-called “salt mirrors” results in exceptionally flat expanses of wetland suitable for solar evaporation pans. Whether in the form of evaporites, eutectic deposits, domes or other rock salt deposits, the mechanism is proposed to be responsible for transporting most waste material into deep aquifers in the water table: Specifically the interface of fresh water and heavy saturated brines in the water table initiates powerful horizontal and vertical liquid streams which are capable of collecting most sediment waste material and concentrating it into heavy gradient saline pools. Based on observations made in 1953 and presented to the 4th Salt Symposium by M.R.Bloch, it is also proposed that this mechanism is responsible for the collecting function of huge quantities of decomposing biodiversity waste and transporting it to subterranean reservoirs where it subsequently is transformed to crude petroleum. Historically this mechanism became nature's process of recycling waste to great depth in the Earth's aquifers. However during the relatively very short period since the Industrial Revolution mankind's raw chemical and nuclear waste has been added to the equation and it is estimated that as the interface of saturated brine continuously rises together with the water table, this will percolate up through the aquifers and a flood of concentrated and highly dangerous magma may inundate lowland aquifers. This will be particularly true in the event that the water table rises due to predicted increased sea levels. The salt-driven wetlands and other historical saline concentrations and salt deposits are an integral part of the process in this mechanism and therefore careful control of these saline streams at their point of evolution must become a priority to sustaining these wetland ecosystems. The technology for handling and redirecting the heavy saline streams is now developing in the form of Aqua harvesting of algae cultivations such as *Dunaliella* and which we consider to be the prime raw material used by nature in the natural production of crude oil. The technology of collecting systems used in the production of energy and heating systems developed in gradient solar ponds is also well advanced, and includes the even older technologies used in the evaporation ponds of ancient salt making needed to produce the required extremophile environment. To ensure the sustainability of wetlands, both control of dangerous waste streams and their processing in the form of recycling is required.

KEYWORDS: Biogenic pools, solar ponds, geothermal, salinity streams, gradients, aqua-harvesting, waste, eutectic event, salt mirror, extremophiles, *dunaliella*.

1. EUTECTIC SALT FORMATION and ICE AGE sea levels

Geologists have debated as to how the varied subterranean salt deposits were formed. An Evaporite mechanism is generally thought to have been responsible for most of the salt

deposits. The thickness and purity of many evaporite beds are hard to explain. How could such a pure evaporite be deposited over periods of thousands of years without a trace of other chemical sediments? If the salt evaporite was deposited *quickly* due to a mechanism other than long periods of concentration by evaporation, the thickness and purity might be easily explained. Thus a Eutectic event may alternatively have been the mechanism responsible for forming some of the classic piercing domes and freezing the flowing and streaming brines through aquifers

Heavy super saturated and stratified brines have been observed forming in brine pools or solar ponds and then sinking through water table aquifers. Since the above ground temperatures for example during the recent Ice age may have been well below the eutectic point of saltwater such brines could have quite quickly frozen *in situ* on their downward journey gravitating into the water table aquifers to great depth.

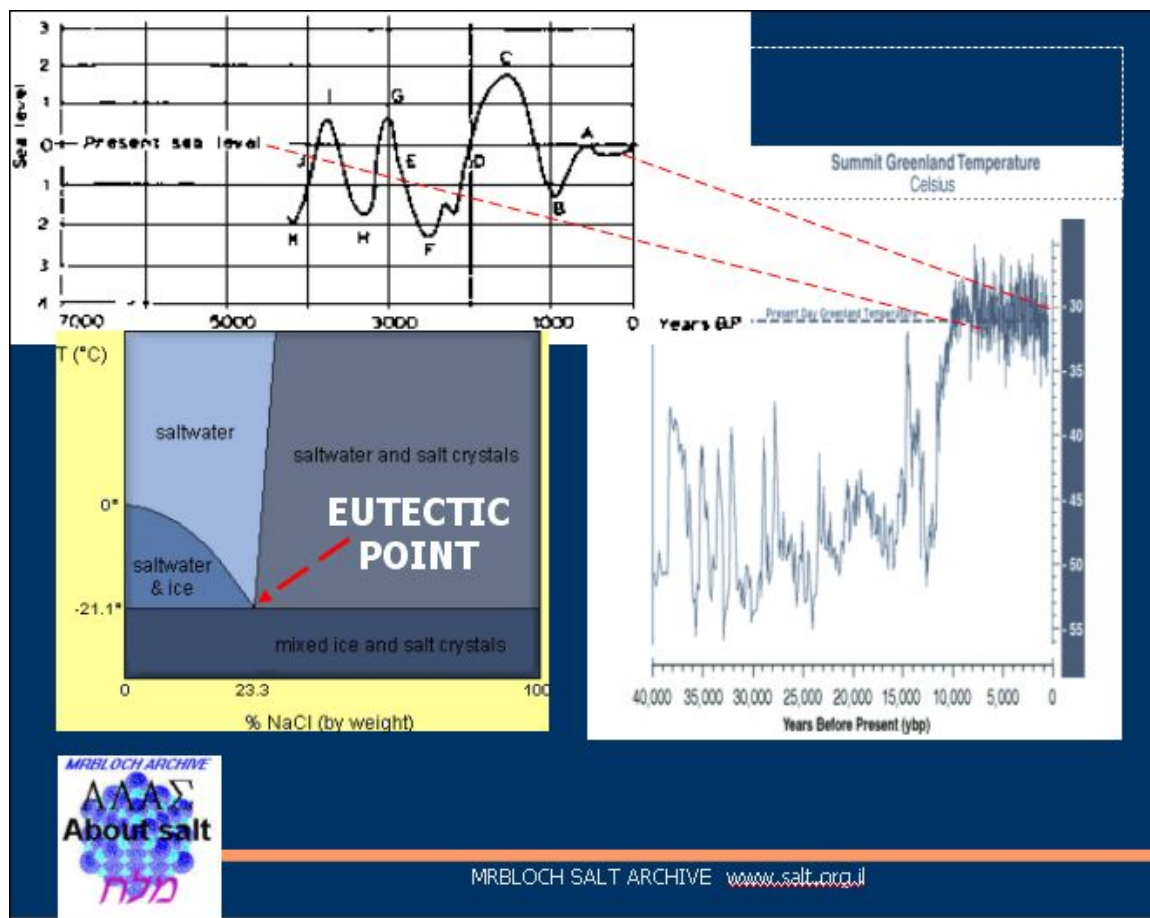


Figure 1. The combination of temperature, brine concentration and timing, is proposed to have created a Eutectic effect and pure salt deposits in situ in the aquifers

For example during the last ice age sea levels were more than 100 meters below present sea levels. Lagoons, Sabkhas and solar ponds, particularly along sea coasts and shelves were exposed. In order to imagine these areas one only need look at a marine atlas map showing the [minus] -60m to -100 m contour line below present sea level. Major lagoons clearly exposed at these historic sea levels during the last ice age may be short listed for example the North Sea, Gulf of Mexico, Hudson Bay, Persian Gulf and the Red Sea, Central Mediterranean, Yellow sea and the now controversial North Pole basin. However, in between ice ages historical sea levels seem to have been much higher generally lowering the relative saturated brine interface in the water table.

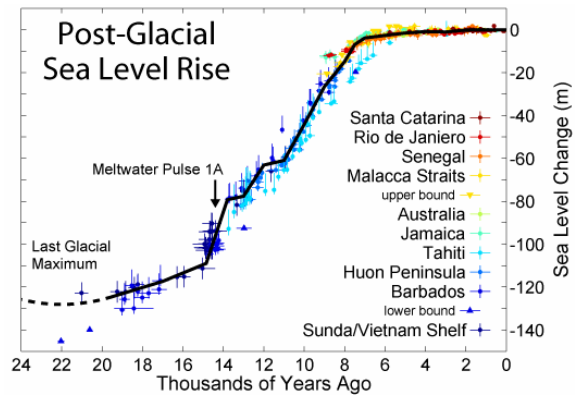


Figure 2. Marine atlas map showing examples of exposed lagoons at the contour minus - 100 meter below present sea level indicating conditions for forming typical natural solar pond sites and reservoirs of heavily concentrated saline organic loaded brines

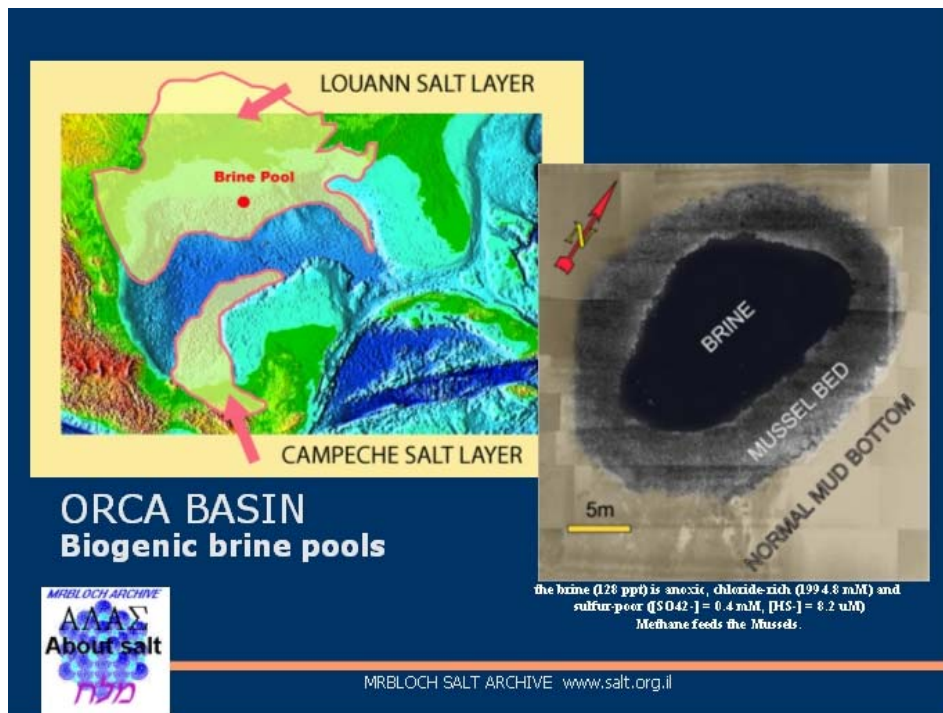


Figure 3. Example of Brine pools collecting on the bed of the ocean floor

The minus -100 meter contour would seem to expose crater like lagoons where extreme salinity gradients became possible. Many recently discovered concentrated brine pools are typical of super saturated brines collecting on the floor of such lagoon basins either as in a solar pond or as an overflow percolating and rising from aquifers flooded with heavy gradient brines indicating the brine interface level within the water table.

2. SALT MIRRORS

Salt mirrors evolve from rock salt diapirs or salt deposits, into the familiar very flat expanses we recognise as wetlands. Salt precipitation in solar evaporation ecosystems occurs in shallow flat ponds. Static brines in Bardawil Sabkha type lagoons or collecting basins of sea water or below springs producing highly saline solutions are normal occurrences and are mostly due to the relatively small volumes of brine exposed to solar

energy. Where the brine is replenished concentration may reach saturation and super saturation, and huge quantities of salt may be laid down on the bottom of these basins but this in itself does not result in the familiar flatness. Over a relative period of time these vast expanses of salt crusting are observed to re-form into very precise flat “mirrors”. The impression of a levelling of the basin floor is given, with the precipitated salt as filler lining the lagoon or lake bed. A typical example, the Bonneville Salt Flats might be used to show the resulting smooth and very flat salt crust stretching for miles in the Utah valley. The seismic cross-section of the salt lake bed is evidence of the layers of precipitation through the seasons, culminating in a so-called salt mirror. Measurements have demonstrated the flatness of Bonneville to a slope of 1:9000 as has its continued use by those seeking to improve world land speed records.

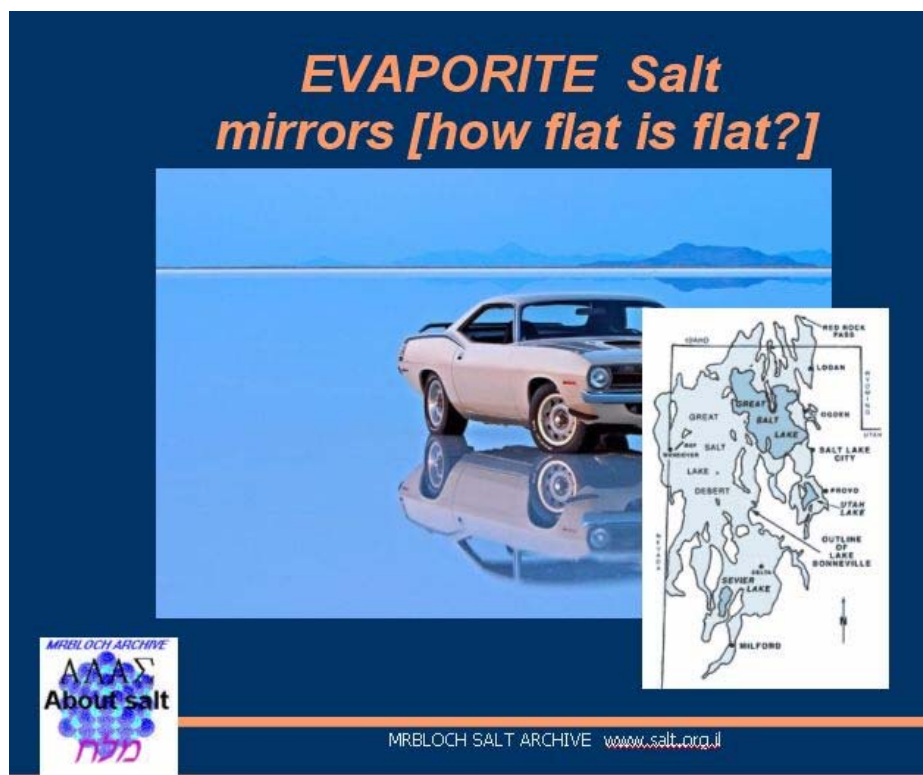
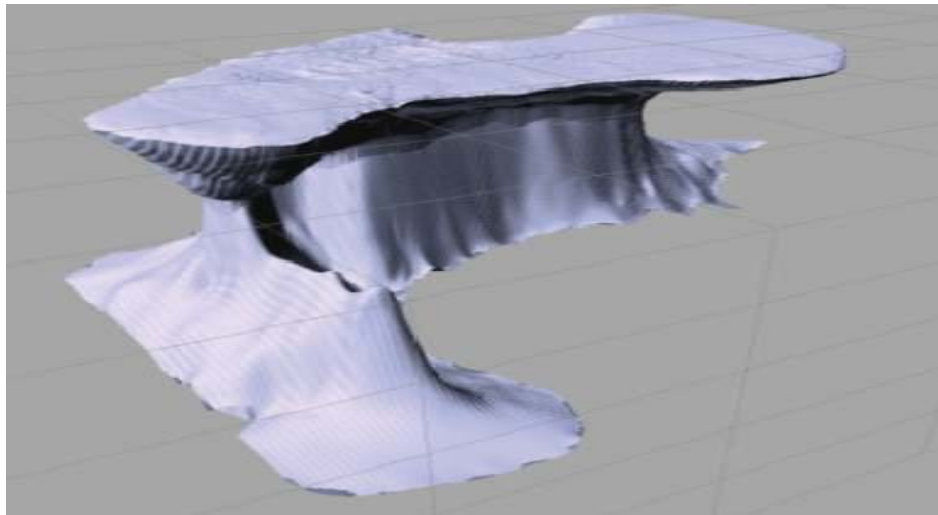
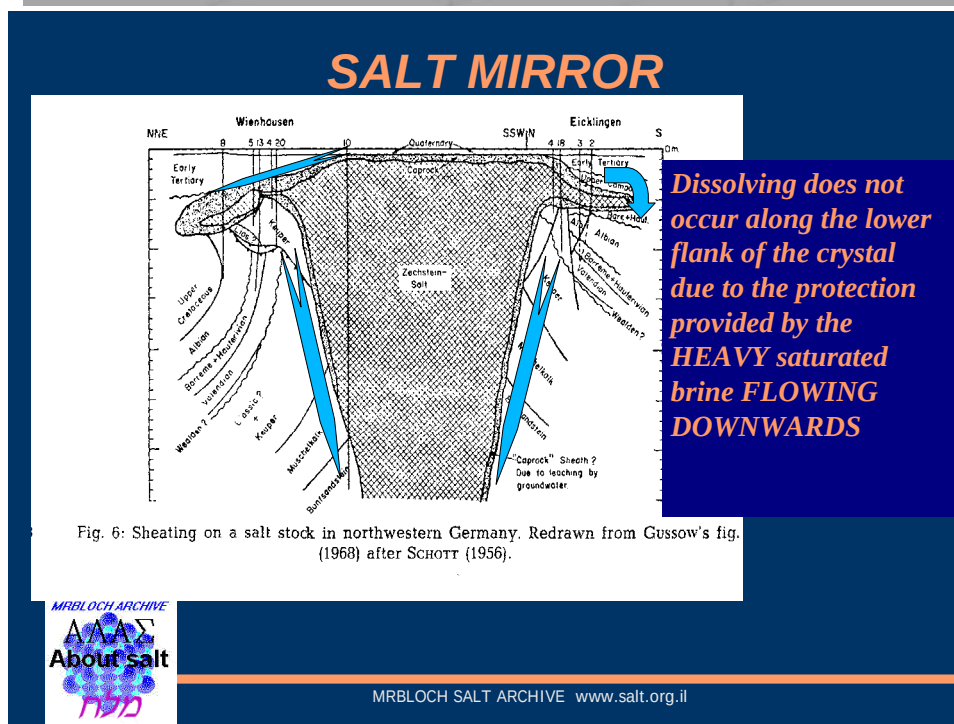


Figure 4. Bonneville salt flats – a salt mirror formed by a salt dissolving process at the interface of saturated brines and in-coming fresh water

The apparent flatness common to most wetlands under discussion is proposed to be the result of hydro geological conditions and water finding its own level leaving solids suspended in the water to settle over a period of time in conformation with the water line. The suspended solids, including precipitating salt are deposited according to the dynamics of wind driven water velocities and wave action. “Siltting” alone can not produce such a very flat surface unless coincidental conditions are in place neither does it guarantee the kind of flat surfaces found at many salt sites including Bonneville. This also still does not fully explain the very precise level and flat formation of the salt flats commonly found albeit parallel to the spherical surface of the earth. Similar flat contours such as at Salt Lake, Utah are also found in many coastal areas used for solar evaporation systems and hence it may be possible to assume that a similar mechanism is in operation. It would therefore appear to be explained by the saturated and super saturated brine interface levels within the water table which is responsible for the flatness.



A]



B]

Figure 5. Typical salt stock dome 3D model [a] and cross section [b] that could have been formed by a Eutectic event and now the basis for migrating heavy brines to great depth

In order to demonstrate the simple physics of a rock salt or evaporite re-formation, and its influence on the landscape of most salt driven “wetlands” ecosystems : we can dissolve two round 25 mm diameter sodium chloride tablets in water to simulate the forming of a typical salt mirror reflecting the resulting nearly perfect horizontal stream of solution. A block of rock [tablet 25 mm diameter] salt placed in a jar of water and the dissolving process may then be observed. Saturated heavy brine begins to collect around the top hemisphere of the salt and flows down its flanks displacing the lighter surrounding water that is not yet in contact with the salt. The stream of heavier now saturated brine that develops along the flank and below the stock of salt also protects it from further dissolving. This adherence of the brine to the flanks of the solid salt is due to a “teapot effect.” Fresh water now can only dissolve the top of the salt above the interface of already saturated brine. Over time the dissolving process creates a mirror like flat surface. The heavy saturated brine collects as a gradient at some lower point trapped only by lack of further seepage. Where aquifers are available and seepage occurs these

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25 mm diameter Sodium Chloride tablet after 12 hours dissolving in fresh water

WATER TABLE

SATURATED BRINE

BASIN FLOOR

25 mm

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Simulation of the natural hydraulic mechanism

- Sand filled volume
- Saline gradient
- Solid salt deposit
- Stratified brine does not mix with fresh makeup water

The diagram illustrates a natural hydraulic mechanism. A central vertical pipe is shown. At the top, a valve is labeled 'FRESH WATER'. Below this, a section of the pipe is labeled 'solid SALT'. The pipe passes through a 'WATER TABLE' (represented by a blue horizontal line). Below the water table, the pipe continues down into a 'STRATIFIED BRINE' region. A 'Heavy saturated brine' arrow points down the pipe, while a 'Light fresh water' arrow points up. A circular inset shows a cross-section of the pipe with a sand-filled volume and a saline gradient. The diagram is labeled with 'MRBLOCH ARCHIVE' and 'About salt'.

This simple hydraulic circuit within the confines of the water table may operate continuously with the heavy brines dragging any suspended or sediment material at that

gradient [mainly organic matter] to a great depth thousands of meters into the water table aquifers. The heavy brines are displaced by lighter incoming fresh water. Flat expanses like Bonneville are found in almost any environment where this brine concentration cycle can evolve whether inland or on ocean coasts. They finally depend on the water level of the lake or the sea level at the coast and the brine interface level in the water table. Deposited or precipitated solid salt will eventually create the conditions to form new flats where the salt deposits combined with fresh makeup water are part of the cycle.

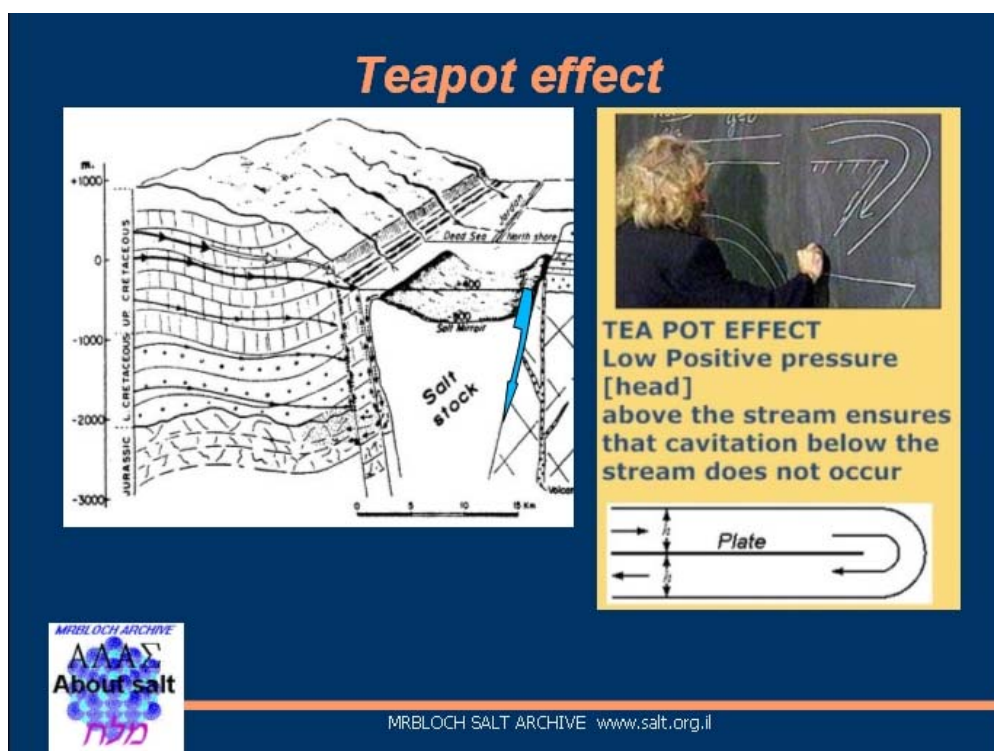


Figure 8. Teapot effect - on a typical salt stock at the Dead Sea – Adhering brine along the flanks of the salt protect the stock from further dissolving

3. WASTE DUNALIELLA into CRUDE OIL

It seems that within the known categories of biodiversity, *Dunaliella* algae are quickly becoming very popular with industrial entities particularly of Pharmaceutical products . However given the physical circumstances of the alga in its natural environment previously described in the water table, it would seem that nature has instead been responsible for its conversion to hydrocarbon - crude petroleum. The optimum growth temperature for *D. salina* is in the range of 20 to 40°C (Borowitzka, LJ, 1981a) depending on the strain. *Dunaliella salina* can tolerate extremely low temperatures to below freezing (Siegel et al., 1984), but temperatures greater than 40°C are usually lethal. There is also a strong interaction between the growth rate, temperature and salinity (Gimmler et al., 1978; Borowitzka, MA & Borowitzka, 1988a) and between light intensity and temperature tolerance (Federov et al., 1968) . Halophile algae, especially of the *Dunaliella* type, grow in nature in aqueous media having a high salt content, such as salterns. Such algae can be cultivated in order to obtain a convenient source of lipids, carotenes, proteins, glycerol and hydrocarbon mixtures essentially similar to fossil oil. See, for example, U.S. Pat. No. 4,115,949. For such cultivations, the conditions must be suitably adapted and as a result achieving sustainability of wetlands. One of the main limitations in the cultivation of halophilic algae in salty solutions is the velocity of transfer of carbon dioxide from air into the solution. Exchange with the atmosphere results in a surface layer, which serves as a source of carbon dioxide for lower layers of higher alkalinity, which have become depleted of carbon dioxide due to the metabolism of the algae. A further limiting factor is

the low velocity of conversion of carbon dioxide to H_2CO_3 when dissolved in brine. In a wetland environment satisfactory conditions of cultivation can be provided by replenishing evaporated water in a suitable manner and by adding certain additives adapted to further the rate of growth of DS algae. The technology is now well developed.

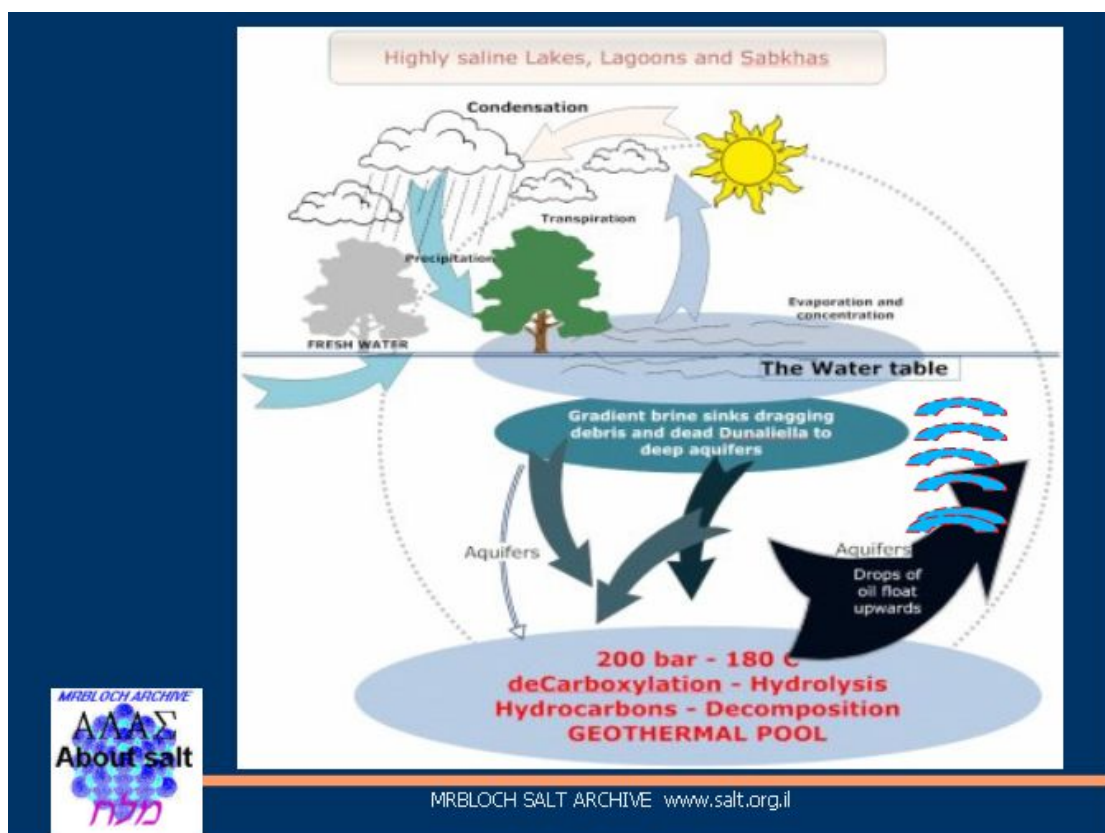


Figure 9. Scheme showing the natural cycle

4. SUMMARY

The transport mechanism described purports to explain how waste matter migrates into depth through the aquifers entrained in heavy saltwater, is soluble but becomes insoluble when heated up in a deep geothermic pool. Only proteins will do this: and for this reason much of the crude oil discovered comes from proteins and not lipids and the oils formed contain short chains, nitrogen and sulphur. The lipids are the source of kerogene and not of the crude oil, and they are not transported to great depth by the salt streams. The lipids are filtered off when the salt brine sinks through the porous light water aquifers. The saltwaters associated with oil traps become less concentrated the further away they get from the stagnant geothermic pool - the original source of the oil droplets. Essentially, after being transported in the heavy salt brine streams to great depth, algae proteins hydrolysed and pyrolysed, **are the natural origins of oil**. This is an ongoing process, and seems to occur rapidly, indicating that the world's oil reservoirs maybe continually 'topped-up' Clearly this transport mechanism may also transfer other waste materials including toxic and other dangerous waste. Depending on changes in the water table level the salinity interface may fluctuate and percolate through existing aquifers penetrating environments and bodies of water considered safe from such dangers. Since these inundating heavy brines are relatively warm they may also have a sudden temperature influence on great bodies of water.

It may be concluded that simulating this transport mechanism by preventing the loaded streams from entering the aquifers and redirecting the potential waste to recycling production units would contribute greatly to the sustainability of salt driven wetlands by

producing salt concentrations for brine concentration - Alga production – Petrol-carbon chemicals [and alternative fuels] – CO2 consumption – and sweet water desalination.



Figure 10. Chain of sustaining technologies including: Desalination and sweet water production, Salt production and brine concentration, Algae production, pharma production

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