Electronic Supplementary Material (ESI) for Lab on a Chip.

Supplementary information 1: Materials

Fluids

Oil. The oil was prepared from a stock collection held at University of Aberdeen. Light components were removed prior to use by heating at 40°C under a nitrogen stream to yield an oil with properties as summarized in Table S1.

Table S1. Properties of the test oil used in the experiments. SARA = saturate, aromatics, resins, asphaltene; TAN = total acid number; SPE = solid phase extraction.

viscosity (mPa s at 25°C)	**density** (g/cm^3 at 20°C)	**SARA** (%)				**TAN** (mg KOH)	**SPE acid-extractables** (mg/g oil)
		Saturate	**Aromatic**	**Resin**	**Asphaltene**		
76 ± 9	0.88 (28-30 API°)	55	28	5-7	10-12	5.3	9.51

***Aqueous phase*.** Coastal seawater was collected from Aberdeen (57° 9'44.76"N, 2° 4'37.95"W) in June 2012. For quality control purposes its TDS content was determined by conductivity and the concentration of two conservative ions (calcium and magnesium) monitored using colourimetry (Palintest Systems procedures PHOT.12 and PHOT.21). These values are within the range of those typically reported for seawater.

Table S2. Seawater properties at 20°C.

						bulk contact angle	
viscosity (mPa s)	**density** (g/cm^3)	**pH**	**alkalinity**	**TDS**	**composition** (mg/L)	**feldspar**	**silica**
1.039	1.0238	7.9	214	33275	1554 Mg; 230 HCO_3^-; 137 Ca	66°	73°

Solids

Orthoclase. Orthoclase feldspar was prepared by crushing a single crystal from a reference mineral collection held at University of Aberdeen. The crushed sample was sieved to yield a 60 μm fraction. Fine particles were removed by heating the sieved powder in 20% HCl at 40°C for 24h. This treatment procedure also has the effect of rounding off the edges of particles (Fig. S1); this may or may not be desirable depending on the final application. Removing fine grained fractions is particularly important as they cause blockages, particularly at the gap filter, which interfere with the operation of the device.

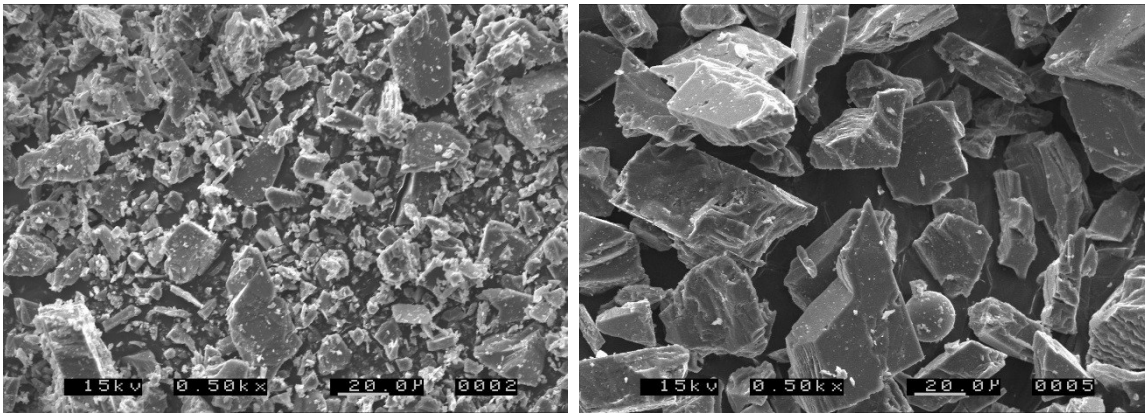

Figure S1. SEM images of crushed orthoclase before (left) and after (right) acid treatment.

Calcite. Calcite grains were prepared by crushing a block of white marble from Carrara, Italy using a mortar and pestle. The powder was sieved to yield a 63 μm fraction. Fine particles were removed and grain size further reduced by rinsing the sieved powder with 20% HCl and deionised water iteratively at ambient temperature.

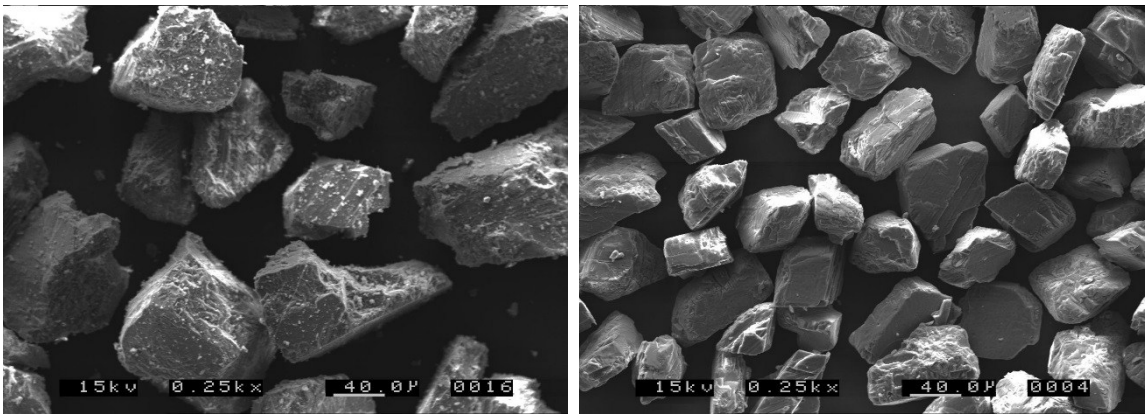

Figure S2. SEM images of crushed marble before (left) and after (right) acid treatment.

Silica. Commercially available 22.81μm soda lime glass (74.0% SiO_2) spheres (White House Scientific, UK) were used. The sphere diameter is normally distributed about 22.81μm with a standard deviation of 0.78μm (Fig. S3).

Table S3. Grain shape and porosity of a uniform region of a packed bed. Porosity was measured by point counting under plane and cross polarized light using a petrographic microscope.

	grain diameter (μm, mean ± 3 standard deviations)	**circularity**	**porosity**
silica	22.81 ± 2.4	1	0.39
feldspar	63 ± 28	0.79 ± 0.07	0.36
marble	53 ± 24	0.79 ± 0.07	0.45

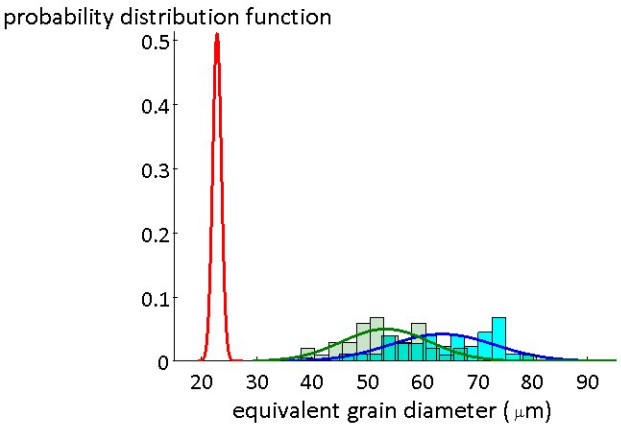

Fig. S3. Equivalent grain size distribution in packed beds of silica (red), calcite (green), and feldspar (blue). The solid lines are normal distributions fitted to data: (mean, standard deviation) = (22.81, 0.78), (53, 8), and (63, 10) μm for silica, calcite, and feldspar, respectively.