Signal & Image Centre

University of Jordan

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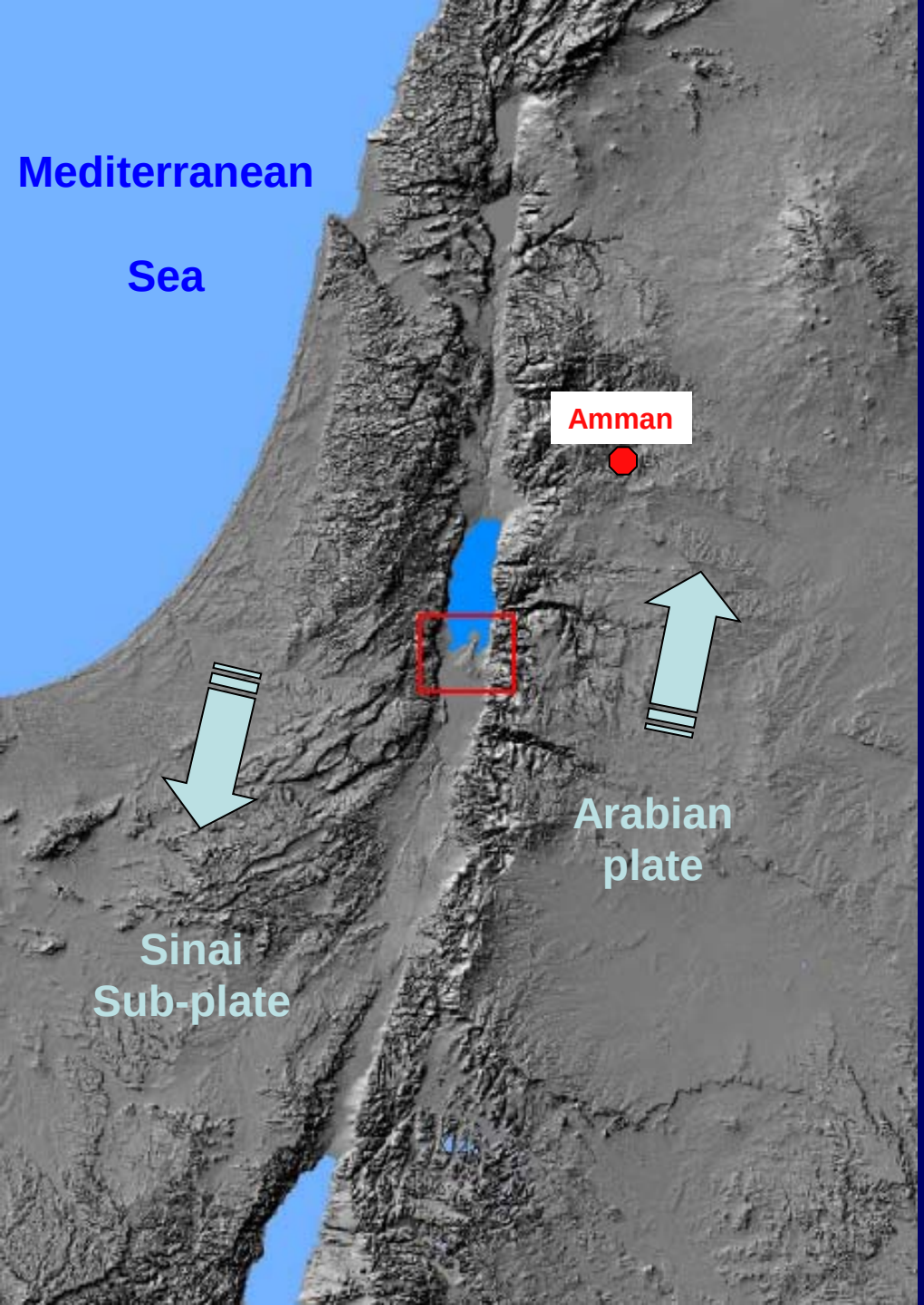
Dead Sea Karst System Dynamics

Measured with Insar PS and SBAS Techniques

NH8 - Environmental and other Hazards (Heavy Metals, Karst, Radon, Space Weather)

NH8.4 Sinkholes: from susceptibility to risk evaluation and mapping

EGU 2011 – Poster XY 383

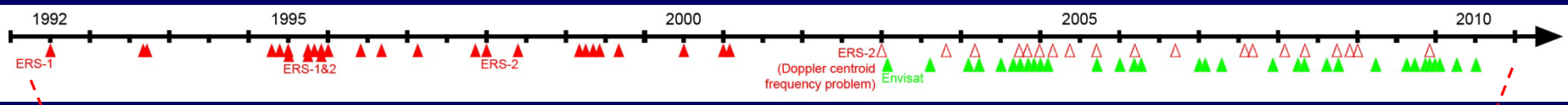


Tectonic Setting

The Dead Sea Transform (DST), also known as the Dead Sea Fault System, is a north-south striking left-lateral shear zone extending from the incipient oceanic ridge (Red Sea) in the south to the Taurus plate collision in the north (Turkey).

About 105-110 km of left-lateral displacement between the African and Arabian tectonic plates took place along this fault system during the last 15 million years.

The average rate of motion during the last 5 million years is 5 millimeters per year.



ERS and Envisat dataset processed from 1992 to 2010

Changes in the Surface Level of the Dead Sea & in the Total Stability of the Dead Sea Water Column

1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Meters below MSL: 404 406 408 410 412 414 416 418 420 422 424

Water Column Stability KJ per m²: 700 600 500 400 300 200 100 0

Level

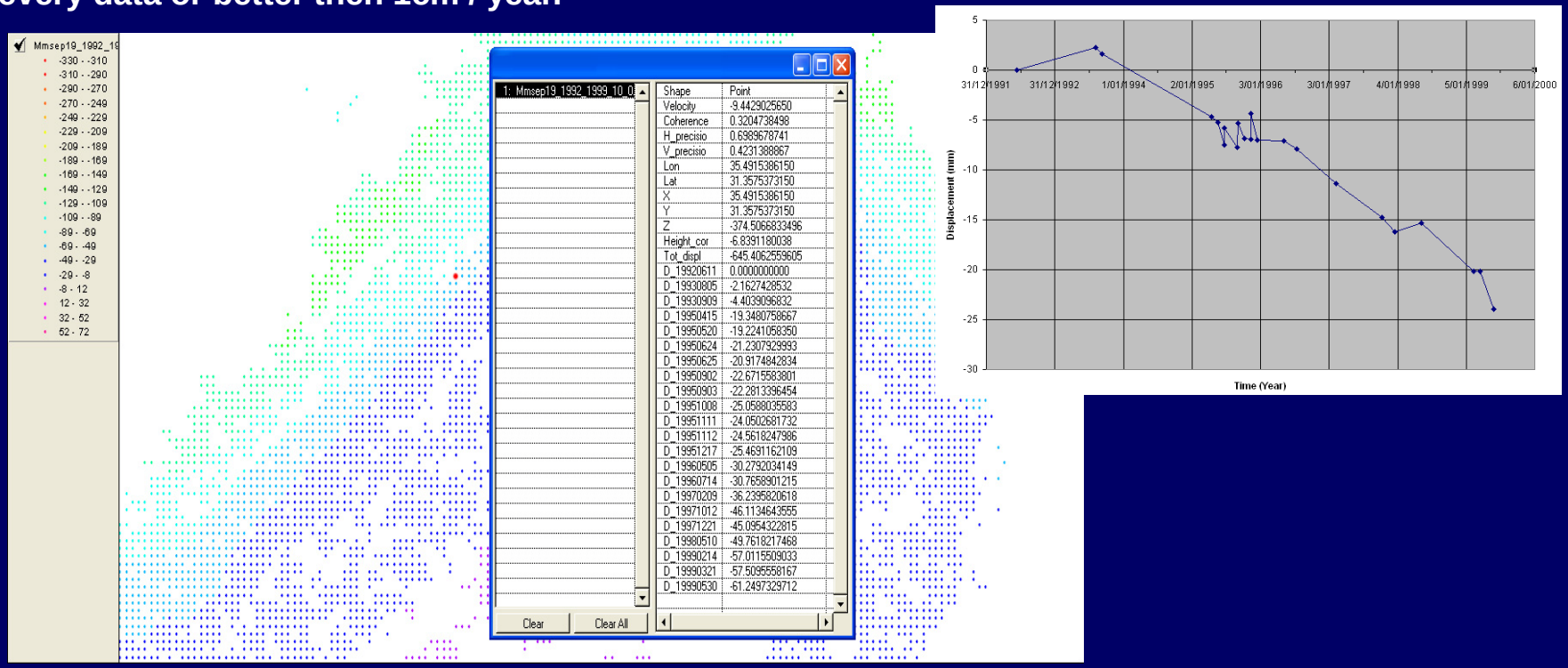
Stability

Holomictic period

Meromictic period

PS & SBAS Techniques

The SBAS processing [1] has been carried out by exploiting the Interferometric Stacking module of the SARscape®[2] COTS software package. Two separate time series, one for the ERS-1/2 and one for the ASAR data, have been analyzed. The pixels that show consistent radar backscatter have been identified over the area, and both a location time series and an average displacement rate has been derived for them, with an accuracy respectively better than 1cm for every data or better then 1cm / year.



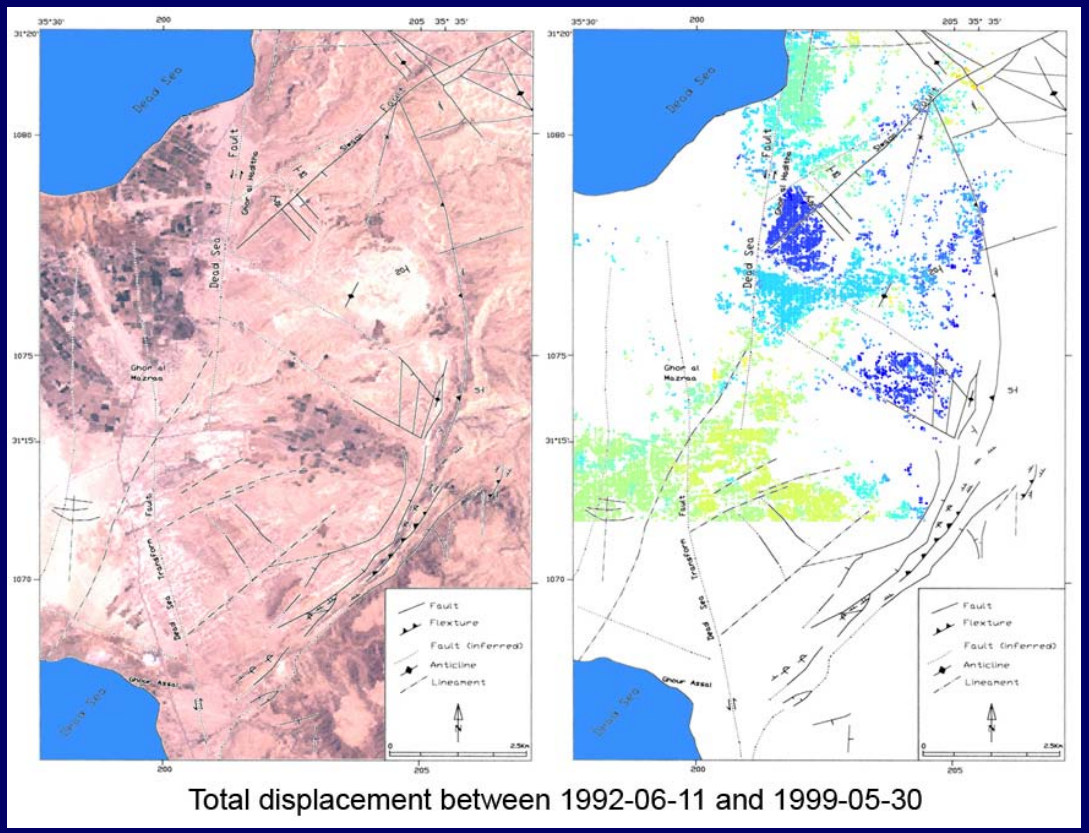
[1] Berardino, P.; Fornaro, G.; Lanari, R.; Sansosti, E.; , "A new algorithm for surface deformation monitoring based on small baseline differential SAR interferograms," Geoscience and Remote Sensing, IEEE Transactions on , vol.40, no.11, pp. 2375- 2383, Nov 2002.

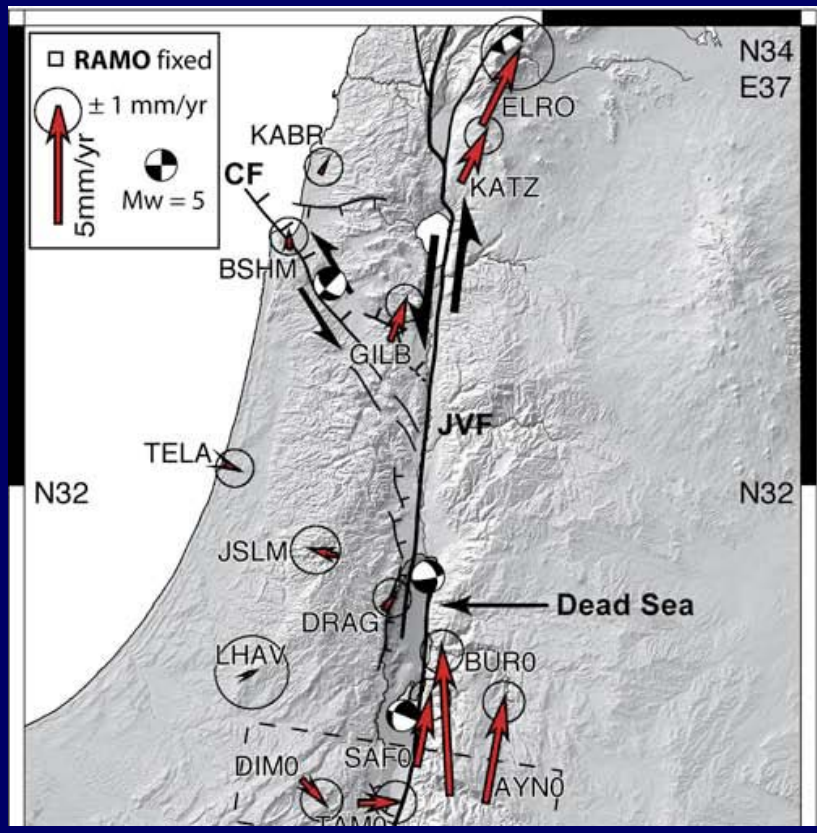
[2] http://www.sarmap.ch/pdf/SARscapeTechnical.pdf

Preliminary Results

• **Validation**
General agreement between our work with previous ones about the period 1992-1999

• **Added value of this work**
Extended the periods of observation 1992-2001 & 2003-2010



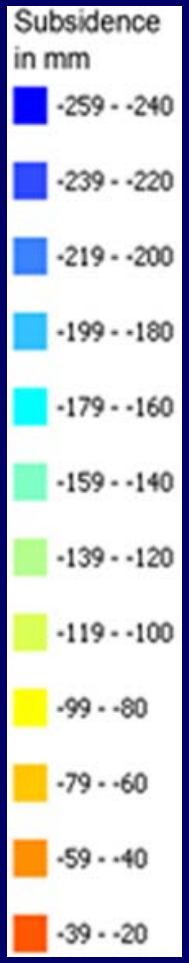


Source: Le Beon, M., Y. Klinger, A. Q. Amrat, A. Agnon, L. Dorbath, G. Baer, J.-C. Ruegg, O. Charade, and O. Mayyas (2008), ***Slip rate and locking depth from GPS profiles across the southern Dead Sea Transform***, J. Geophys. Res., 113, B11403, doi:10.1029/2007JB005280.

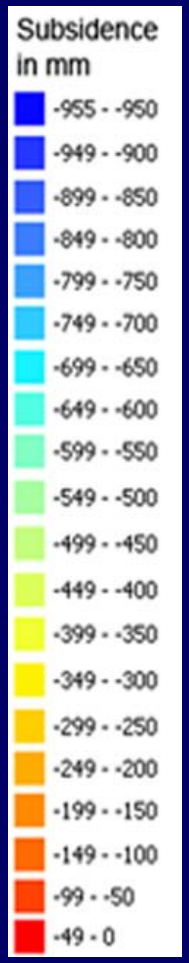
New Results

Salt karst deformations along the Dead Sea coast mapped with ALOS palsar radar images. Closson, Damien; Abou Karaki, Najib; Milisavljevic, Nada; Hallot, Frédéric; Acheroy, Marc; Meghraoui, Mustapha EGU General Assembly 2010, held 2-7 May, 2010 in Vienna, Austria, p.4065

1992-2001
Ref Img 1992



2003-2010
Ref Img 2003



Questions

- Is there a limit to the increase of subsidence ?

- What will happened in this decade to the agricultural, industrial and touristic infrastructures?

Source: www.sciencephoto.com

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Dead Sea salt karst system dynamics measured with Insar PS and SBAS techniques

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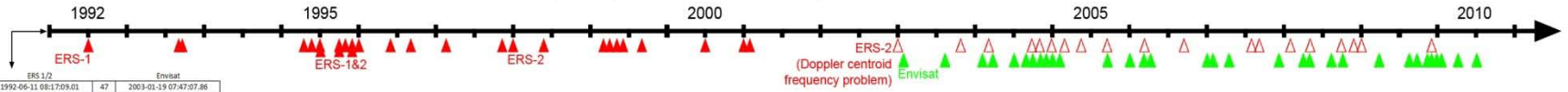


	ERS 1/2		Envisat
1	1992-06-11 08:17:09.01	47	2003-01-19 07:47:07.86
2	1993-08-05 08:17:13.44	48	2003-07-13 07:47:14.36
3	1993-09-09 08:17:14.56	49	2004-01-04 07:47:17.81
4	1995-04-15 08:17:09.49	50	2004-03-14 07:47:16.59
5	1995-05-20 08:17:13.18	51	2004-06-27 07:47:17.89
6	1995-06-24 08:17:15.10	52	2004-08-01 07:47:20.24
7	1995-06-25 08:17:17.74	53	2004-09-05 07:47:18.54
8	1995-09-02 08:17:14.65	54	2004-10-10 07:47:18.83
9	1995-09-03 08:17:17.42	55	2004-11-14 07:47:16.69
10	1995-10-08 08:17:22.08	56	2004-12-19 07:47:13.46
11	1995-11-11 08:17:14.34	57	2005-01-23 07:47:14.59
12	1995-11-12 08:17:16.08	58	2003-08-21 07:47:17.38
13	1995-12-17 08:17:19.20	59	2005-12-04 07:47:13.31
14	1996-05-05 08:17:18.41	60	2006-02-12 07:47:07.35
15	1996-07-14 08:17:16.95	61	2006-03-19 07:47:04.90
16	1997-02-09 08:17:08.71	62	2006-12-24 07:47:13.77
17	1997-10-12 08:17:11.98	63	2007-01-28 07:47:08.04
18	1997-12-21 08:17:08.90	64	2007-03-04 07:47:10.41
19	1998-05-10 08:17:08.80	65	2007-11-04 07:47:08.72
20	1999-02-14 08:17:07.21	66	2008-03-23 07:47:07.59
21	1999-03-21 08:17:07.16	67	2008-04-27 07:47:05.60
22	1999-04-25 08:17:08.34	68	2008-07-06 07:47:08.31
23	1999-05-30 08:17:10.39	69	2008-09-14 07:47:04.73
24	1999-07-04 08:17:06.03	70	2009-03-08 07:47:03.02
25	2000-06-18 08:17:08.19	71	2009-07-26 07:47:06.09
26	2000-12-10 08:17:11.18	72	2009-08-30 07:47:05.39
27	2001-01-14 08:17:13.46	73	2009-10-04 07:47:01.12
28	2002-12-15 08:15:33.05	74	2009-11-08 07:47:01.49
29	2003-10-26 08:15:40.46	75	2009-12-13 07:46:58.44
30	2004-02-08 08:15:39.48	76	2010-01-17 07:46:59.21
31	2004-09-05 08:15:52.48	77	2010-03-28 07:46:58.67
32	2004-10-10 08:15:48.59	78	2010-06-06 07:46:56.53
33	2004-12-19 08:15:49.25		
34	2005-02-27 08:15:42.53		
35	2005-04-03 08:15:45.08		
36	2005-07-17 08:15:51.20		
37	2006-02-12 08:15:38.92		
38	2006-08-06 08:15:50.70		
39	2007-07-22 08:15:40.63		
40	2007-08-26 08:15:33.04		
41	2008-01-13 08:16:28.69		
42	2008-04-27 08:17:01.74		
43	2008-08-10 08:17:06.22		
44	2008-11-23 08:17:01.52		
45	2008-12-28 08:17:19.94		
46	2009-11-08 08:18:28.26		

Images acquired before and after an earthquake in the Dead Sea area (11Feb04, 20Nov07, 13Apr08)

Images perturbated by atmospheric conditions

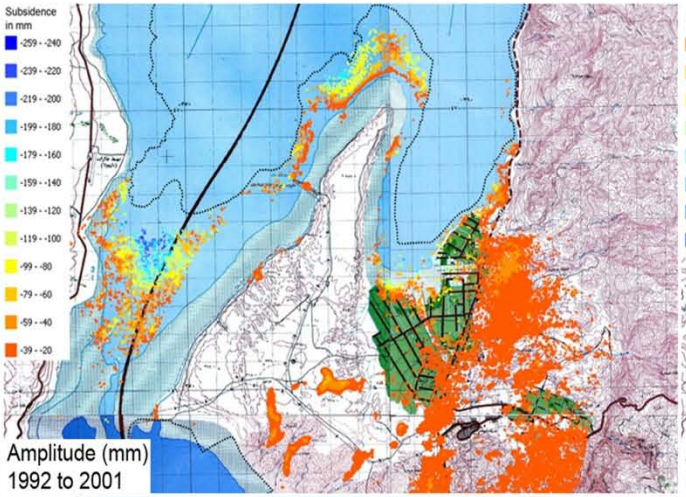
Present-day coastal zone due to the Dead Sea level lowering (1m/yr)

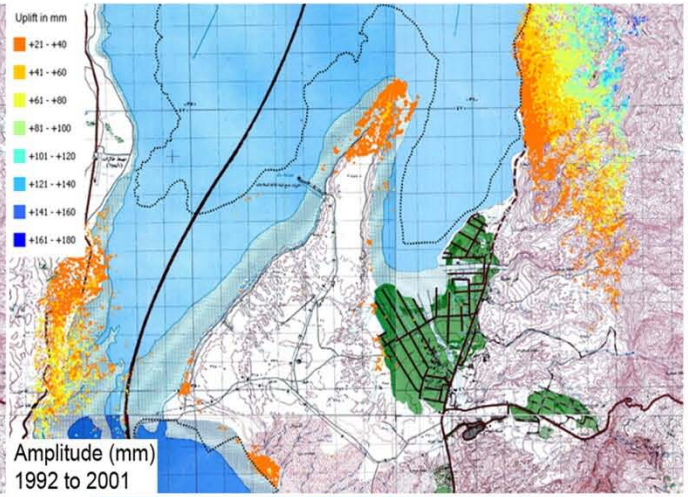
Jordanian Topographic map merged subsets

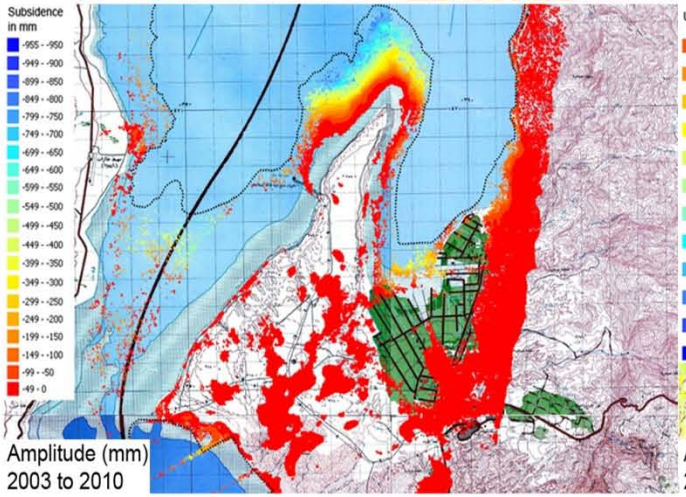
Language	Contour Interval	Units	Serie	Sheets	Scale
Arabic/English	Varies: 20m, 10m	Meters	K737	3152 - I, II, III, IV	1:50k
Survey	Geogr. Coord. Sys. (GCS)	Proj.	Datum		Spheroid
1961-1963	1000m UTM (36)	Trans. Mercator	Vert.: Mean sea level at Aqaba Hor.: ED1950 (Egypt)		International 1924

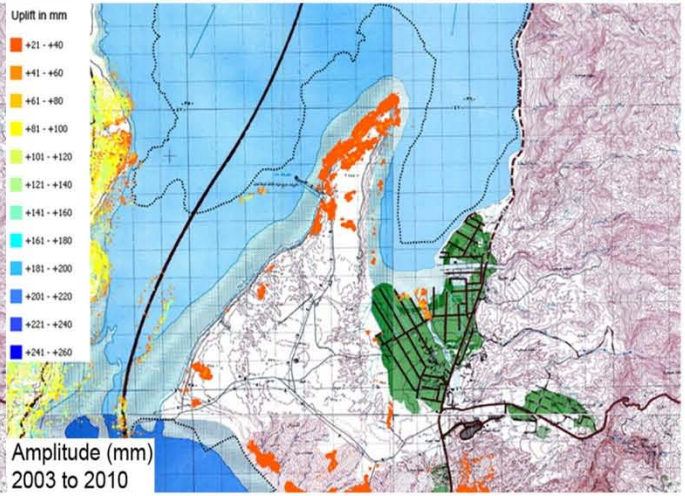
SUBSIDENCE

UPLIFT

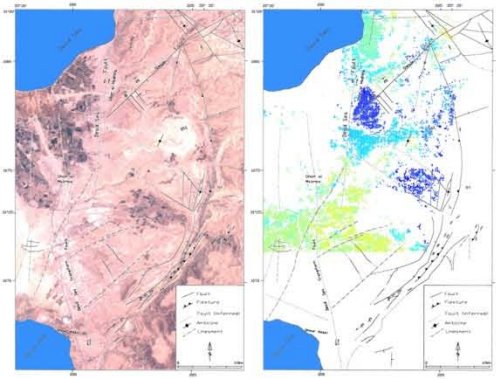








Interpretation/validation



Total displacement between 1992-06-11 and 1999-05-30

See also XY579 EGU2011-9342: Paolo Pasquali, Damien Closson, Paolo Riccardi, Alessio Cantone, and Massimo Barbieri
Comparison of Interferometric SAR and Multispectral time series for determination of Atmospheric Phase Screen