

UNEXPECTED GEODYNAMICAL PERSPECTIVE OF THE SINAI AREA BY GPS

Federica Riguzzi ^(a) and Salah Mohamed Mahmoud ^(b)

(a) Istituto Nazionale di Geofisica, via di Vigna Murata 605, 00143 Rome Italy
phone ++39 6 51860266, fax ++39 6 51860303, e-mail riguzzi@ingrm.it

(b) National Research Institute of Astronomy and Geophysics, Helwan, Cairo Egypt

ملخص

إن هذا المقال يعرض النتائج المحصل عليها بفضل التحليل المرفق لشبكة محلية لأجهزة تحديد المواقع، ممتدة من خليج السويس إلى شبه جزيرة سيناء، ولشبكة جهوية لأربع محطات دائمة لأجهزة تحديد المواقع، ممتدة من إسرائيل إلى قبرص. يظهر التحليل الخاص بعمليتي المسح المكررتين، إزاحات معتبرة في مواقع سيناء وقبرص. يمنح التقييم التقريبي للسرعات النسبية والمتوسطة إلى شبه جزيرة سيناء وقبرص أكبر قيم الشبكة، بحوالي 0.3 سم/في السنة و 2.4 سم/في السنة على التوالي. تتضاءل السرعة إلى حوالي 60% من قيمتها (1.8 سم - 1.4 سم/في السنة) على طول الانشقاق المحول المرجح للبحر الميت-الأردن. إن أنواع السرعات النسبية تدل على وجود تقدم نشيط على طول القسم المتواجد في أقصى جنوب نظام الانشقاق لعقبة في حين أن جزء البحر الميت - الأردن الذي يظهر إزاحات غير مهمة يمكن توقيفها. إن الإزاحات النسبية التي تم رصدها عبر منطقة خليج السويس تظهر عنصر ضغط. هذه الصورة الجيوديناميكية تقود إلى تفسيرين ممكنين: الأول هو أن حركة الانفتاح لخليج السويس قد تم تحويلها بصفة كاملة إلى حركة الانزلاق الناتجة عن الانشقاق المحول للعقبة-المشرق. أما التفسير الثاني فهو أنها صادرة فقط من التأثيرات الناتجة عن الزلازل.

في هذا المجال يتوجب إجراء عمليات مسح أخرى بأجهزة تحديد المواقع حتى يتسنى حقيقتنا فهم النوع الجيوديناميكي لشبه جزيرة سيناء.

RESUME

Cet article présente les résultats obtenus grâce à l'analyse jointe d'un réseau GPS local de 11 sites, allant du golfe de Suez jusqu'à la péninsule de Sinaï, et d'un réseau régional de 4 stations GPS permanentes allant d'Israël jusqu'à Chypre. L'analyse de deux levés renouvelés démontre des déplacements importants aux sites de Sinaï et de Chypre. Une évaluation approximative des vitesses relatives moyennes accorde à la péninsule de Sinaï et à Chypre les plus hautes valeurs du réseau avec respectivement 3.0cm/ Année et 2.4cm/ Année environ. La vitesse diminue jusqu'environ 60% de sa valeur (1.4-1.8cm/ Année) tout au long de la faille transformante supposée de la Mer Morte-Jordanie. Les types de vitesses relatives indiquent la présence d'un avancement actif le long de la partie extrême sud du système de faille de Aqaba, alors que le segment de la Mer Morte-Jordanie présentant des déplacements insignifiants, peut être bloqué. Les déplacements relatifs détectés à travers la zone du golfe de Suez présentent une composante compressive. Cette image géodynamique mène à deux interprétations possibles : la première est que le mouvement d'ouverture du golf de Suez a été entièrement transféré sur le mouvement de glissement dû à la faille transformante du Aqaba-Levant, la seconde interprétation est qu'il provient exclusivement des effets post-sismiques.

Dans ce contexte, d'autres levés GPS sont nécessaires pour comprendre réellement le type géodynamique de la péninsule de Sinaï.

ABSTRACT

This paper shows the results obtained by the joint analysis of a local GPS network of 11 sites, from the Suez Gulf to the Sinai peninsula, and a regional network of 4 permanent GPS stations, from Israel to Cyprus. The analysis of two repeated surveys shows significant displacements at the Sinai sites and Cyprus. A rough estimation of the mean relative velocities gives for the Sinai peninsula and Cyprus the highest values of the network with about 3.0 cm/y and 2.4 cm/y respectively. Velocity decreases at about 60% of its value (1.4 -1.8 cm/y) along the Dead Sea - Jordan transform fault. The relative velocity pattern indicates the presence of active creeping along the southernmost part of the Aqaba fault system, while the Dead Sea-Jordan segment, showing insignificant displacements, could be locked. The relative displacements detected across the Gulf of Suez area shows a significant compressional component. This geodynamical picture leads to two possible interpretations: the first is that the opening motion of the Gulf of Suez has been entirely transferred on the strike-slip motion of the Aqaba-Levant transform fault; the second is that it originates exclusively as post-seismic effect. In this context, other GPS surveys are required to really understand the geodynamical style of the Sinai peninsula.

Key words: GPS, displacement, post-seismic effect, Sinai, Aqaba-Levant fault

1. Introduction

The utility of GPS to detect crustal deformations at various scale dimensions is widely recognized, so that permanent GPS arrays are currently used for this purpose all over the world. Anyway, non-permanent networks play important roles in control surveys devoted to geophysical purposes at various network scales, both regional where few or not at all permanent stations are available (e.g. the African shore of the Mediterranean Sea) and local when it is economically not convenient to establish permanent GPS arrays. In this respect, the joint analysis of both permanent and non-permanent GPS arrays may be very useful to improve the analysis itself if a rigorous procedure is carried out.

The aim of this paper is to give a contribute to the study of the present-day geodynamics of the Sinai area by the joint analysis of a local GPS network composed by 11 sites located on the north-eastern corner of the African plate, from the Gulf of Suez to the Sinai peninsula, and a regional network composed by 4 permanent GPS stations, from Israel to Cyprus. The regional network is useful to constrain and to strengthen the solution of the local one.

2. Regional tectonic sketch

The area under investigation is comprised from latitude 27N to 36N and longitude 32E to 36E. Here, the Gulf of Suez area, the Sinai peninsula, the Aqaba-Levant Dead Sea transform fault system and Cyprus are included (Fig.1). From a geophysical point of view, the area is very interesting because its tectonics is mainly dominated by the active boundary between the African and the Arabian plates which are separating one from the other and where large deformations with high seismic activity take place.

From Neogene to Late Miocene, different phases of motion interested the Gulf of Suez and the Aqaba-Levant area: at the beginning, the north-eastward motion of the Arabian peninsula yielded the opening of the Red Sea with the characteristics of a new young basin and presence of extensional tectonics. Subsequently, the opening mainly interested the Red Sea and propagated along the Gulf of Suez area. In the end, the opening of the Suez area slowed and the Red Sea rift created a NNE left shear motion with extensional component in the Aqaba-Levant area.

Many geological and seismological investigations were developed in this area for petroleum researches since the beginnings of this century, so that now it is usually accepted that the Sinai peninsula is a sub-plate of the African plate which

accommodates the main motion of the Aqaba left-lateral transform fault with the low extensional motion of the Suez Gulf, in the framework of the Red Sea opening [1]. This sub-plate is bordered on its western margin by the Gulf of Suez, on its eastern side by the great Dead Sea-Jordan transform fault system and toward north by the Cypriot convergent arc.

The triple junction among the Gulf of Suez rift, the Aqaba-Levant transform fault (the southernmost part of the Dead Sea-Jordan transform) and the Red Sea rift is located south of the Sinai peninsula. The question of whether the triggered motion of the Aqaba-Levant fault system has entirely or partially replaced the Gulf of Suez opening is still under discussion.

Geological studies show that the oldest movements of the Aqaba-Dead Sea fault zone are surely younger than those in the Suez basin, thus suggesting the end of the extension of the Gulf of Suez and the transfer of the motion along the Aqaba-Levant fault zone about 10 Ma ago. According to these studies, the Gulf of Suez shows, at present, very low rates of extensional feature (< 1 mm/y) and tectonic subsidence [2]; on the contrary, the Aqaba-Levant transform system displays a higher rate of motion with geological evidences suggesting an average value of about 8-9 mm/y [3]. The Dead Sea-Jordan fault system extends over about 450 km, from the Gulf of Elat to the northern margin of the Hula Valley, where a complicated transition zone from the sinistral strike slip style toward the thrust components of the Taurus arc take place.

The tectonics of the Dead Sea-Jordan fault system is really much more complicated than the above mentioned description. In fact, although it is considered a sinistral transform as a whole, some peculiar characteristics appear at local scale [4]. First of all, the fault system is discontinuous and broken in a series of en-echelon left lateral strike slip faults that die out to the north by bending toward north-east [5]. Along the bending and the stepping of the faults, many pull-apart basins (like the Dead Sea itself) and push-up swells (like the Golan and the Hermon mountains) are generated, making peculiar local tectonic stress complications [6-7]. The expected present-day motion along the transform fault zone is about 1.5 cm/y [8].

Seismic activity mainly occurs along the borders of the Sinai sub-plate: in the southern part of the Gulf of Suez, along the Aqaba-Levant fault system, where it reaches the highest level, along the Dead Sea-Jordan transform; on the contrary, the intraplate seismicity is spread and low (Fig.1). Focal mechanism solutions show extensional

features in the southernmost part of the Gulf of Suez (only two events in late sixties [9]), left lateral strike slip and extensional styles in the southernmost Dead Sea-Jordan fault system (the Aqaba-Levant area) while, toward north, the strike slip component is prevailing. The largest earthquake occurred on November 22, 1995 in the Gulf of Aqaba with magnitude $M_w=7.2$. From south to north, the seismic activity decrease along the Dead Sea-Jordan transform fault system and then increase again toward the Cyprean arc, where is generally clustered south-west of Cyprus and shows some compressional components [10-13].

3. Data analysis

The local network consists of 11 non-permanent GPS stations, seven located on the Sinai Peninsula and the other four on the west shore of the Gulf of Suez. Two GPS campaigns were carried out with dual frequency Trimble 4000SSE and 4000SSI receivers [14]. The first in 1997, from November 20 to December 2; the return campaign was performed in 1998, from May 25 to 31. The observing session time span was 8 hours with 30 s sampling rate. Not all the sites were measured at the same time, being limited the number of the receivers involved in the two campaigns, so that the inclusion of the four GPS permanent stations into the analysis seems to be crucial to improve the analysis itself (Table 1 and 2). The permanent GPS tracking site are located in Israel (ELAT, TELA and KATZ) and in Cyprus (NICO), so that the final network is composed by a local part having a mean baseline length of about 50 km and a regional part with mean baseline length of about 200 km.

The data analysis was performed according to a standard procedure [15] consisting in GPS data processing, network adjustments and comparison between the two network solutions by a statistical analysis to evaluate the significance of the observed coordinate differences. Taking into account the regional size of the network, in the following we focus our attention on two-dimensional (planar) analysis. In the end, the computation of the 2D vector displacements and the corresponding error ellipses on the local tangent plane is done.

GPS data processing was performed by the Bernese GPS software v. 4.0, developed at the Bern University [16], following the manual suggestions given for mixed network. Precise ephemerides, satellite clock corrections, antenna height phase center variations and some other general files provided by CODE (Center of Orbit Determination in Europe) of the Bern University were included into the computation. Relative and absolute tropospheric delay parameters every two hours were estimated respectively for local and long

baselines, starting from the Saastamoinen standard model.

Each observing session was processed separately. All the session solutions pertaining to each campaign were adjusted by NETGPS, a software suitably implemented to analyze GPS networks [17]. Table 3 shows some global parameters of the two network adjustments: the number of parameters estimated (unk.), the estimated variance of unit weight (σ_0^2), the number of equations (eq.) and the total observation redundancy (red.). Moreover the estimated and threshold χ^2 values testing the correctness of the normal variate observation model are reported. The test is passed by an iterative procedure when the estimated χ^2 results less than the threshold value.

Table 4 shows the precision of the two adjustments (1997 and 1998) in terms of maximum and mean error ellipse semiaxes (computed on the local tangent plane) at 95% confidence level. The maximum semiaxes range within 0.8 cm and the mean is within 0.6 cm. Note that the precision achieved for the 1997 is better than the 1998 adjustment; this fact is clearly due to a higher observation redundancy (in 1997 there are more observing sessions). Moreover, the joint solution between the two networks improves the accuracy of about 20% with respect to the Sinai local network single solution [18].

The observed coordinate differences between the two coordinate sets were submitted to the significance analysis by DENETGPS. This software performs a test based on the Fisher variate with the aim to separate the sites into two groups, those with coordinates significantly changed with respect to the error ellipsoids from the others whose coordinates are not changed. DENETGPS was successfully tested in suitably designed experiments by producing known displacements on one site of a GPS network [15], [19]. Table 5 shows the results of the analysis at 5% significance level in which the experimental Fisher values F_e are compared with the threshold value F_t ; sites with $F_e > F_t$ exhibit significant coordinate differences.

The analysis on the planar component shows how all the coordinate differences pertaining to the 7 sites located on the Sinai peninsula result significant, while the remaining 5 sites display small differences within the errors; moreover, significant is the difference detected for NICO. The result obtained by the present analysis confirms that the whole Sinai peninsula exhibits a rather uniform behaviour with the highest detected motion of the whole analyzed area. This fact is particularly evidenced by computing the 2D displacement vectors, their azimuths and the corresponding error

features in the southernmost part of the Gulf of Suez (only two events in late sixties [9]), left lateral strike slip and extensional styles in the southernmost Dead Sea-Jordan fault system (the Aqaba-Levant area) while, toward north, the strike slip component is prevailing. The largest earthquake occurred on November 22, 1995 in the Gulf of Aqaba with magnitude $M_w=7.2$. From south to north, the seismic activity decrease along the Dead Sea-Jordan transform fault system and then increase again toward the Cyprian arc, where is generally clustered south-west of Cyprus and shows some compressional components [10-13].

3. Data analysis

The local network consists of 11 non-permanent GPS stations, seven located on the Sinai Peninsula and the other four on the west shore of the Gulf of Suez. Two GPS campaigns were carried out with dual frequency Trimble 4000SSE and 4000SSI receivers [14]. The first in 1997, from November 20 to December 2; the return campaign was performed in 1998, from May 25 to 31. The observing session time span was 8 hours with 30 s sampling rate. Not all the sites were measured at the same time, being limited the number of the receivers involved in the two campaigns, so that the inclusion of the four GPS permanent stations into the analysis seems to be crucial to improve the analysis itself (Table 1 and 2). The permanent GPS tracking site are located in Israel (ELAT, TELA and KATZ) and in Cyprus (NICO), so that the final network is composed by a local part having a mean baseline length of about 50 km and a regional part with mean baseline length of about 200 km.

The data analysis was performed according to a standard procedure [15] consisting in GPS data processing, network adjustments and comparison between the two network solutions by a statistical analysis to evaluate the significance of the observed coordinate differences. Taking into account the regional size of the network, in the following we focus our attention on two-dimensional (planar) analysis. In the end, the computation of the 2D vector displacements and the corresponding error ellipses on the local tangent plane is done.

GPS data processing was performed by the Bernese GPS software v. 4.0, developed at the Bern University [16], following the manual suggestions given for mixed network. Precise ephemerides, satellite clock corrections, antenna height phase center variations and some other general files provided by CODE (Center of Orbit Determination in Europe) of the Bern University were included into the computation. Relative and absolute tropospheric delay parameters every two hours were estimated respectively for local and long

baselines, starting from the Saastamoinen standard model.

Each observing session was processed separately. All the session solutions pertaining to each campaign were adjusted by NETGPS, a software suitably implemented to analyze GPS networks [17]. Table 3 shows some global parameters of the two network adjustments: the number of parameters estimated (unk.), the estimated variance of unit weight (σ_0^2), the number of equations (eq.) and the total observation redundancy (red.). Moreover the estimated and threshold χ^2 values testing the correctness of the normal variate observation model are reported. The test is passed by an iterative procedure when the estimated χ^2 results less than the threshold value.

Table 4 shows the precision of the two adjustments (1997 and 1998) in terms of maximum and mean error ellipse semiaxes (computed on the local tangent plane) at 95% confidence level. The maximum semiaxes range within 0.8 cm and the mean is within 0.6 cm. Note that the precision achieved for the 1997 is better than the 1998 adjustment; this fact is clearly due to a higher observation redundancy (in 1997 there are more observing sessions). Moreover, the joint solution between the two networks improves the accuracy of about 20% with respect to the Sinai local network single solution [18].

The observed coordinate differences between the two coordinate sets were submitted to the significance analysis by DENETGPS. This software performs a test based on the Fisher variate with the aim to separate the sites into two groups, those with coordinates significantly changed with respect to the error ellipsoids from the others whose coordinates are not changed. DENETGPS was successfully tested in suitably designed experiments by producing known displacements on one site of a GPS network [15], [19]. Table 5 shows the results of the analysis at 5% significance level in which the experimental Fisher values F_e are compared with the threshold value F_t ; sites with $F_e > F_t$ exhibit significant coordinate differences.

The analysis on the planar component shows how all the coordinate differences pertaining to the 7 sites located on the Sinai peninsula result significant, while the remaining 5 sites display small differences within the errors; moreover, significant is the difference detected for NICO. The result obtained by the present analysis confirms that the whole Sinai peninsula exhibits a rather uniform behaviour with the highest detected motion of the whole analyzed area. This fact is particularly evidenced by computing the 2D displacement vectors, their azimuths and the corresponding error

References

- [1] Ben-Menahem, A., A. Nur and M. Vered, 1976. Tectonics, seismicity and structure of the Afro-Eurasian junction – The breaking of an incoherent plate, *Phys. Earth Planet. Inter.*, 12, 1-50.
- [2] Steckler, M.S., F. Berthelot, N. Liberis and X. Le Pichon, 1988. Subsidence in the Gulf of Suez: implications for rifting and plate kinematics, *Tectonophysics*, 153, 249-270.
- [3] Le Pichon, X. and J.-M. Gaulier, 1988. The rotation of Arabia and the Levant fault system, *Tectonophysics*, 153, 271-294.
- [4] Ron, H. and Y. Eyal, 1985. Intraplate deformation by block rotation and mesostructures along the Dead Sea Transform, northern Israel, *Tectonics*, 4, 1, 85-105.
- [5] Kashai, E.L. and P.F. Croker, 1987. Structural geometry and evolution of the Dead Sea-Jordan rift system as deduced from new subsurface data, *Tectonophysics*, 141, 33-60.
- [6] Heimann, A. and H. Ron, 1987. Young faults in the Hula Pull-Apart Basin, central Dead Sea Transform, *Tectonophysics*, 141, 117-124.
- [7] Reches, Z., 1987. Mechanical aspects of pull-apart basins and push-up swells with applications to the Dead Sea transform, *Tectonophysics*, 141, 75-88.
- [8] Reilinger, R.E., S.C. McClusky, M.B. Oral, R.W. King, M.N. Toksoz, A.A. Barka, I. Kinik, O. Lenk and I. Sanli (1997). Global positioning System measurements of present-day crustal movements in the Arabia-Africa-Eurasia plate collision zone, *J. Geophys. Res.*, 102, B5, 9983-9999.
- [9] Jackson, J.A., N.J. White, Z. Garfunkel and H. Anderson, 1988. Relations between normal-fault geometry, tilting and vertical motions in extensional terrains: an example from the southern Gulf of Suez, *J. of structural Geology*, 10, 2, 155-170.
- [10] Dziewonski, A.M., and J. H. Woodhouse, 1983. An experiment in systematic study of global seismicity; Centroid Moment Tensor solutions for 201 moderate and large earthquakes of 1981, *J. Geophys. Res.*, 88, 3247-3271.
- [11] Fattah, A.K.A., H.M. Hussein, E.M. Ibrahim and A.S.A. El Atta, 1997. Fault plane solutions of the 1993 and 1995 Gulf of Aqaba earthquakes and their tectonic implications, *Annali di Geofisica*, XL, 6, 1555-1564.
- [12] Kalogeras, I., G. Stavrakakis and K. Solomi, 1999. The October 9, 1996 earthquake in Cyprus: seismological, macroseismic and strong motion data, *Annali di Geofisica*, 42, 1, 85-97.
- [13] Salamon A., A. Hofstetter, Z. Garfunkel and H. Ron, 1996. Seismicity of the eastern Mediterranean region: Perspective from the Sinai subplate, *Tectonophysics*, 263, 293-305.
- [14] Mahmoud, S., H. Koivula, A.S. Mohamed, H. Khalil and T. R. Kebeasy, 1998. Monitoring recent movements in Sinai and around Gulf of Suez, Egypt, *The Ninth International Symposium On Recent Crustal Movements (CRCM '98)*, November 14-19, 1998, Cairo, Egypt.
- [15] Crespi, M. and F. Riguzzi, 1998. Software Available for analyzing GPS deformation, EOS, Transaction, American Geophysical Union, 79, 22, 259 and EOS electronic Supplement, http://www.agu.org/eos_elec/98059e.html.
- [16] Rothacher, M., G. Beutler, W. Gurtner, E. Brockmann and L. Mervart, 1995. Bernese GPS Software Version 4.0. Markus Rothacher and Leos Mervart editors. University of Berne, Switzerland.
- [17] Crespi, M., 1996. A software package for the adjustment and the analysis of GPS control networks, in *Reports on Surveying and Geodesy*; ed. Unguendoli M., University of Bologna, edizioni Nautilus, 237-264.
- [18] Riguzzi, F., S., Mahmoud and A. Tealeb, 1999. Displacement pattern of the Sinai area: first result from GPS, *Annali di Geofisica*, 42, 4, 755-762.
- [19] Betti, B., L. Biagi, M. Crespi and F. Riguzzi, 1999. GPS sensitivity analysis applied to non-permanent GPS network, *Journal of Geodesy*, 73, 158-167.
- [20] Kimata F., A. Tealeb, H. Murakami, N. Furukawa, S. Mahmoud, H. Khalil, K. O. Sakr and A. M. Hamdy, 1997. The Aqaba earthquake of November 22, 1995 and co-seismic deformation in Sinai peninsula, deduced from repeated GPS measurements, *Acta Geod. Geoph. Hung.*, 32 (1-2), 53-71.
- [21] Wessel P, Smith W H F (1995) *The Generic Mapping Tools (GMT) version 3.0 Technical Reference & Cookbook*, SOEST/NOAA.

Figure captions

Fig.1: Main tectonic structures and seismic activity ($M \geq 5.0$) of the Middle East area from 1973 (NEIC) to now. Focal mechanisms of the main events ($M_w \geq 5$) reported by the CMT Harvard Catalog are shown in the map [10].

Fig.2: 2D displacement field and error ellipses at 95% confidence level.

TABLE 1: Observing DOYS Of the 1997 network												
SITE	324	325	326	327	328	329	331	332	333	334	335	336
GARB												
GEMS												
HURG												
SHAM												
KENS												
TOUR												
DERB												
CATH												
NABQ												
ZEIT												
DAHA												
ELAT												
TELA												
KATZ												
NICO												

TABLE 2: Observing DOYS Of the 1998 network						
SITE	145	146	148	149	150	151
GARB						
GEMS						
HURG						
KENS						
TOUR						
DERB						
CATH						
NABQ						
ZEIT						
DAHA						
ELAT						
TELA						
KATZ						
NICO						

TABLE 3: global parameters of the network adjustments (5% significance level)							
YEAR	a priori σ_0^2	Estim. σ_0^2	Threshold d χ^2	Exper. χ^2	eq.	unk.	red.
1997	1.00	1.00	119.87	95.61	138	42	96
1998	1.00	0.99	99.62	75.98	120	42	78

σ_0^2 = variance of unit weight; eq.= equations; unk.= unknowns; red.= redundancy

TABLE 4: precision at 95% confidence level		
Year	SMAX (cm)	SMED (cm)
1997	0.5	0.3
1998	0.8	0.6

SMAX and SMED are the maximum and mean values of the error ellipse semiaxes

TABLE 5: planar deformation analysis (5% significance level)	
SITE	$F_t = 3.05$
GARB	2.06
GEMS	0.43
HURG	0.91
SHAM	6.29
KENS	3.42
TOUR	18.46
DERB	7.15
CATH	8.95
NABQ	5.30
ZEIT	0.47
DAHA	7.09
ELAT	0.37
TELA	2.21
KATZ	1.13
NICO	3.37

TABLE 6: 2D displacements, rms and azimuth		
SITE	VT2D±rms (cm)	Azimuth (deg)
GARB	-	-
GEMS	0.6±0.6	169
HURG	1.0±0.7	179
SHAM	1.6±0.6	-164
KENS	1.0±0.6	-145
TOUR	1.8±0.5	-180
DERB	1.6±0.6	-154
CATH	1.7±0.6	-167
NABQ	1.5±0.7	-135
ZEIT	0.4±0.5	172
DAHA	1.6±0.6	-122
ELAT	0.7±0.6	-174
TELA	0.9±0.6	-154
KATZ	0.9±0.6	-162
NICO	1.2±0.7	-164



